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ABSTRACT

This volume presents instructions for 52 low-cost and indigenous teaching materials and devices developed during a second series of national workshops held in Bangladesh, Indonesia, the Republic of Korea, Papua New Guinea, Sri Lanka, Thailand, and the Socialist Republic of Viet Nam during 1979/1980, and also during the second Sub-Regional Workshop on Educational Technology held in Dacca in 1980. Each description lists the subject area, objectives, materials needed, and source. Instructions tell both how to make the item and how to use it, and describes possible modifications when applicable. The items described include hand-made maps, models and displays, educational toys and games, and science apparatus, such as a thermoscope, simple electroscope, simple microscope, osmoscope, plastic beaker, bamboo thermoflask, common pump, spring pendulum, and balances. Instructions are generously illustrated with line drawings. (LMM)

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Low-cost Educational Materials

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INVENTORY
Volume II

UNESCO

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INTRODUCTION

The scarcity of resources in Asia and the Pacific is increasingly recognized as an important impediment in extending opportunities for education and improving its quality.

Especially for young children, the use of familiar items for learning is pedagogically better than the use of sophisticated, unfamiliar items. In other words, the tendency is not only to be looking for lower cost, it is towards looking for more effective learning.

On the other hand, the low cost itself should not be a criterion for cost effectiveness, if the improvisation is causing harm to the required quality of knowledge to be attained. Therefore, the term *cost effective* is to be applied whenever *low-cost* educational materials are concerned.

The Fifth Regional Consultation Meeting on APEID (Bangkok, March 1978) sanctioned the sequencing of the activities relating to the development of low-cost and indigenous teaching devices and materials based on cost-effective techniques. These envisaged the organization of sub-regional workshops, preceded by a series of national workshops organized in the countries participating in the respective sub-regional workshops.

The first series of national workshops were held between August and October 1978 in seven countries. The experiences gained and collected at these workshops were brought together for exchange at the first Sub-regional Workshop in Educational Technology held in Kathmandu, Nepal, in November 1978. At the same time, some additional exemplar materials were prepared, under contract, by various national specialists in the region.

Some selected materials prepared by the Kuala Lumpur Regional Workshop (1977), the national workshops and the Katmandu Sub-regional Workshop (1978) were published in the first volume of the *Inventory of low-cost educational materials*.

This second volume of the inventory consists of instruction sheets developed during the second series of national workshops held in Bangladesh, Indonesia, the Republic of Korea, Papua New Guinea, Sri Lanka, Thailand and the Socialist Republic of Viet Nam during 1979/1980 as well as those developed during the second Sub-regional Workshop in Educational Technology, held in Dacca, 1980, and selected write-ups from national studies and other sources.

ACEID welcomes comments on the inventory, and contributions for possible inclusion in subsequent volumes of the inventory.

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List of participants of the APEID Second Sub-regional Workshop in Educational Technology with special reference to Development of Low-cost Educational Materials (Dacca, 27 October–8 November 1980) . 115

DIORAMA

Level: Infant and primary
Subject area: Story-telling and reading

1. BRIEF DESCRIPTION

This is a TV-box, made of wood or cardboard. Static and animated pictures are placed inside.

2. OBJECTIVES

To illustrate the content of lessons, e.g. to illustrate stories by pictures and by animated elements, thus increasing the attention and developing the imaginative thought of the pupils.

3. MATERIALS NEEDED

1. A piece of plywood (total area about 1 m^2, thickness: 3-5 mm).
2. Cardboard.
3. Two cylinders made of galvanized ironsheet (or wood) 350 - 400 mm long, 1 cm diameter.
4. Two metal rods, 3 mm diameter, 350 - 400 mm long.
5. Two knobs for turning the cylinders.
6. A strip of rubber (800 mm long - 20 mm large).
7. Pictures cut out from newspapers, magazines or self-produced drawing, coloured according to the content of each lesson.
8. Hand-saw, hammer, nails, drill, pliers, glue.

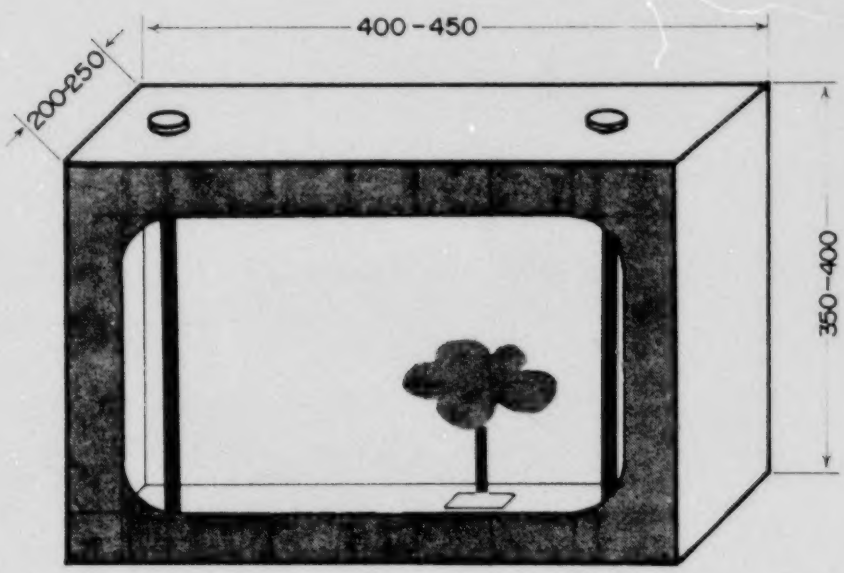


Fig.1

4. HOW TO MAKE

1. Make a TV-box with wooden top and bottom, and cardboard side walls.
2. Cut the screen from cardboard, then nail it to the front of the box leaving the back side open.
3. Fix the two cylinders and the knobs and rods (insert the cylinders as shown in Fig. 1).
   The two cylinders are used to roll a paper strip of pictures with the size as big as the screen (Fig. 2-a), they can also be used to move the rubber strip with characters and figures being fixed on it (Fig. 2-b).

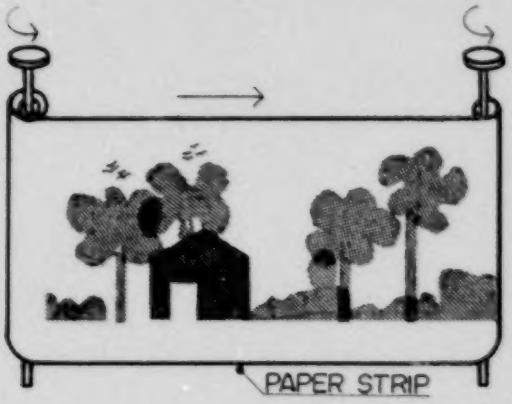


Fig.2 (a)

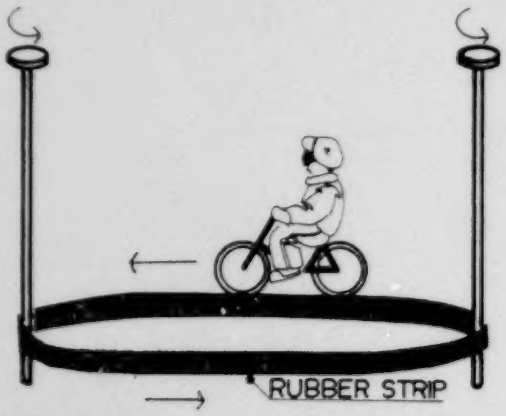


Fig.2 (b)

4. Draw in the background a view of the country-side, or urban area, or a mountainous area, according to the subject of the lesson - this background can be cut from existing pictures.
5. Between the background and the pictures fixed on the strip you can place other figures (Fig. 3) - either drawn or ready-made-inside the box, thus providing the impression of depth of space.

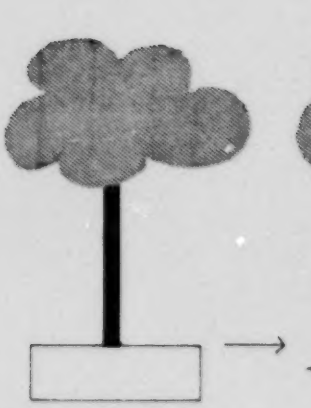


Fig.3 (a)

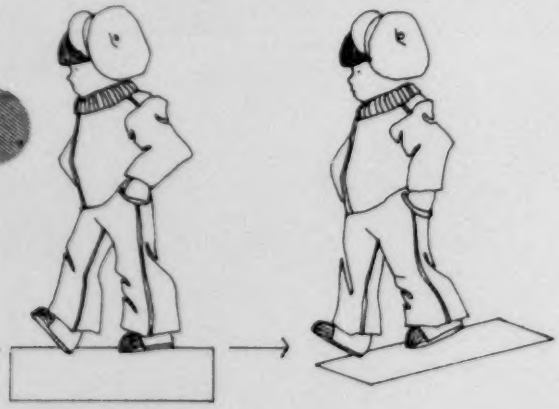
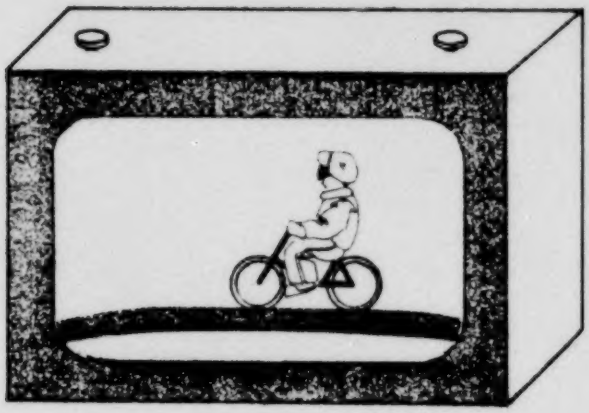


Fig. 3 (b)

5. HOW TO USE

1. Turn the knobs for rolling the paper band of pictures.
2. Turn the knobs to cause the movement of some figures fixed on the strip.

Source: School Equipment Information, No. 4, 1979
Department of School Equipment
Ministry of Education
Socialist Republic of Viet Nam



ANIMATED PICTURE

Level: Infant and middle primary
Subject area: Story telling and reading drills

1. BRIEF DESCRIPTION

This device is an animated picture, consisting of at least two parts, (static and mobile). It can be used in story telling to infants or at an early stage of primary education.

2. OBJECTIVES

To illustrate reading drills and story telling by animated pictures, with much attention paid to the moving elements in order to stimulate the curiosity and attention of the pupils.

3. MATERIALS NEEDED

1. A rectangular card board (250 X 350 mm) or (300 X 400 mm).
2. Coloured paper or coloured pictures cut out of magazines.
3. A piece of thread (300 mm) and a piece of elastic or rubber band (50 mm).
4. Glue

4. HOW TO MAKE

1. Put all parts of the picture in their proper position on one side of the cardboard (Fig. 1).

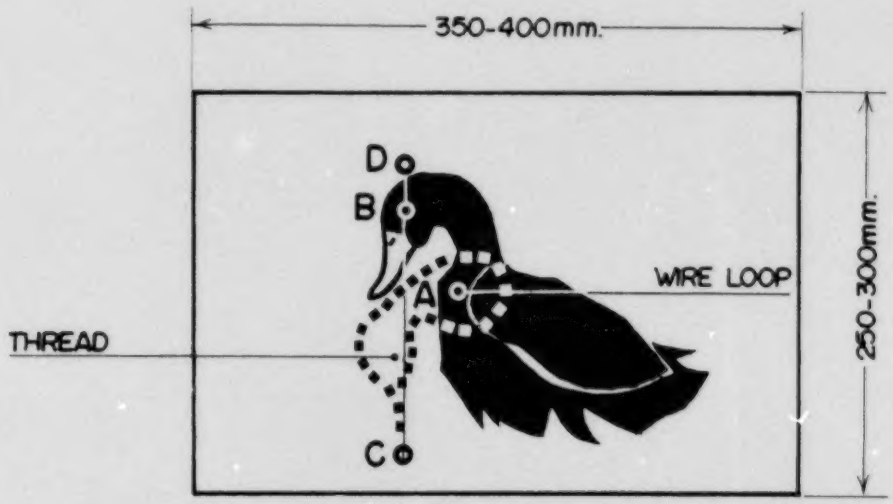


Fig. 1 - FRONT

2. Glue the static parts to the cardboard.
3. The moving part should be glued to a separate piece of cardboard and cut out.

4. The moving part rotates around point A.

5. Fasten at point A with a piece of wire looped at both ends.

6. Tie the thread at point B and pass through the holes at points C and D.

7. Tie the elastic to the thread where appropriate and fasten securely at the back of the cardboard with looped wire at point E (Fig. 2).

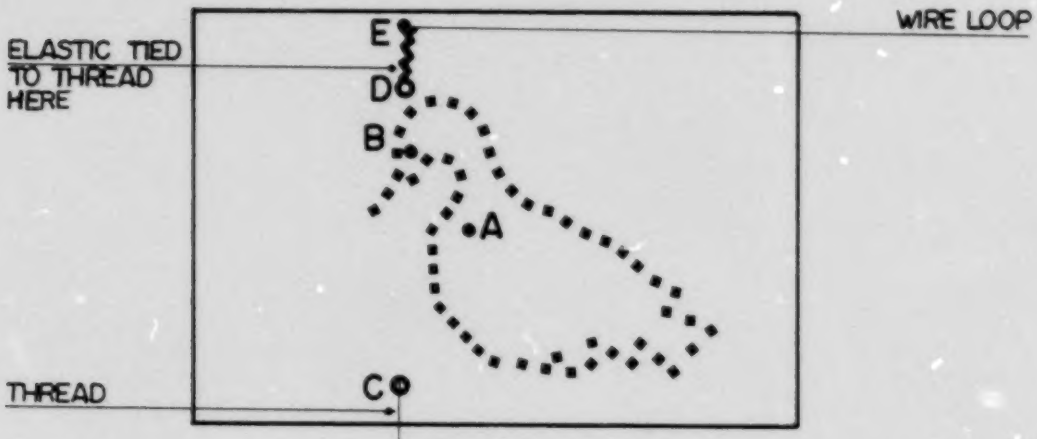


Fig. 2 - BACK

5. HOW TO USE

1. Pull the thread slightly and the bird's head will move.

2. Release the thread and the elastic rubber band will move it back.

6. POSSIBLE MODIFICATIONS

You can draw various pictures on the cardboard, and make the moving parts separately. Many moving parts can be assembled in one picture.

Source: School Equipment Information No. 4/1979
Department of School Equipment
Ministry of Education
Socialist Republic of Viet Nam

SHEET 3

CHALKBOARD

Level: All levels
Subject area: All subjects

1. BRIEF DESCRIPTION

This is a portable chalkboard for pupil or teacher use.

2. MATERIALS NEEDED

1. A piece of plywood or hardboard 1 m x 1.5 m x 10 mm.
2. Smooth sandpaper.
3. Undercoat paint.
4. Chalkboard paint.
5. Turpentine.
6. 50 mm paint brush.

3. HOW TO MAKE

1. Using a piece of sandpaper, go over the whole surface of the plywood, or hardboard, (front and the edges) until you get a smooth surface.
2. Remove the dust produced and give the surface of the board an even coating of the undercoat paint, brushing in one direction only, for example with vertical strokes.
3. When it is completely dry, sandpaper the surface again.
4. Apply the chalkboard paint again, this time brushing with horizontal strokes (if you used vertical strokes in Step 2).
5. Leave to dry.

4. PREPARATION FOR USE

Never write directly onto a newly painted board as the chalk lines will then be difficult to erase. You should "condition" the surface by rubbing the surface of the board with a duster which contains a lot of chalkdust. Use long, even strokes and go over the board at least twice. Finally wipe over with a clean dry duster.

The "pores" of the board will now be filled with dust and future erasing will be easier.

You can now write on your chalkboard.

5. HOW TO USE

1. You can use your new chalkboard for keeping important notes for the children.
2. You can take it out of the classroom, if you want to hold a science lesson outside. During the lesson, you can write important words on the board for the children to copy when back in the classroom.

Source: Making and Using Low-cost Teaching Aids, report of a National Workshop, Port Moresby Teachers In-service College, Papua New Guinea, 28 April - 2 May 1980. Papua New Guinea Department of Education, 1980.

OUTLINE MAP

Level: Primary and secondary
Subject area: Social studies

1. BRIEF DESCRIPTION

Teachers and pupils having difficulty drawing maps on the chalkboard from memory or copying from a school atlas will find this method much easier: Keep each map outline as it can be used over and again.

2. OBJECTIVES

To enable teachers to quickly draw any map on the chalkboard.

3. MATERIALS NEEDED

Thick brown paper, pen or pencil, nail.

4. HOW TO MAKE

1. Use the pen or pencil to draw or trace the map outline you need on a sheet of brown paper. Discarded thick wrapping paper will do (Fig. 1).
2. Using a nail, punch holes along the outline, placing them about 20 mm apart (Fig. 2).

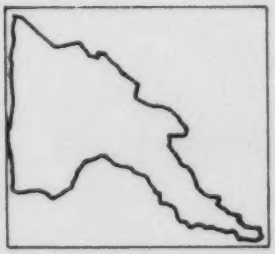


Fig.1

Fig.2

3. Hold the paper against the chalkboard and pat chalkdust from the board duster through the holes in the paper (Fig. 3).
4. Remove the paper and join up the dots with chalk (Fig. 4).

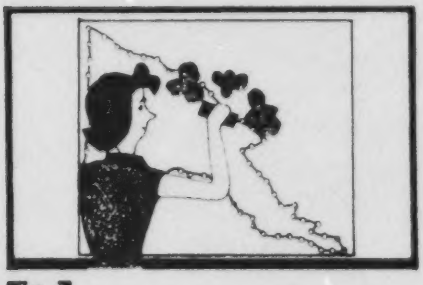


Fig. 3

Fig.4

5. HOW TO USE

Prepare a set of map outlines that will be frequently used at any time, and bind them into a flip chart.

Maps can then be quickly selected and drawn on the chalkboard before the pupils become inattentive.

Source: Making and Using Low-cost Teaching Aids, report of a National Workshop held 28 April - 2 May 1980. Port Moresby, Papua New Guinea.

BAMBOO TRIPOD

Level: Primary and secondary
Subject area: All subjects

1. BRIEF DESCRIPTION

A bamboo tripod can be easily constructed to hold a flannel-board, or flip-chart, or other large, stiff-backed visual materials. It is sturdy, made of low-cost materials, and convenient to carry and use.

2. OBJECTIVES

1. To have a ready tripod in the classroom for holding flannel-board, flip-chart or other large visual materials.
2. To use a low-cost teaching instrument.

3. MATERIALS NEEDED

1. Three 2 m long poles of bamboo.
2. Two 100 mm long wooden pegs.
3. 5 m of strong cord.

4. HOW TO MAKE

1. Drill holes at distances of 60 mm and 1400 mm from the top end in each of the bamboo poles and two other holes A and B, about 150 mm above the lower holes in only two of the poles (Fig. 1).

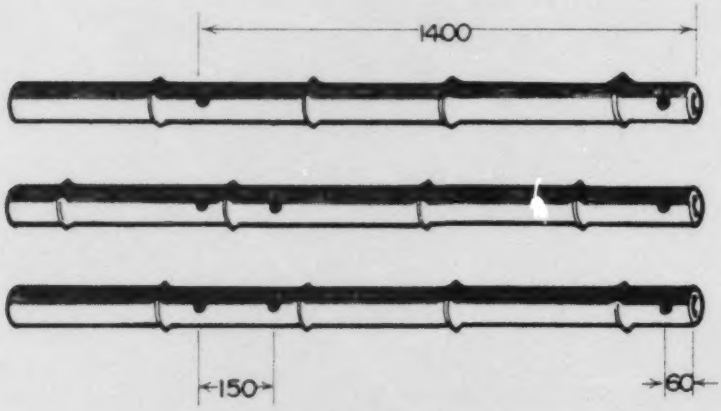


Fig. 1

2. With about 300 mm long strong cord, tie the three top ends together securely, but not so tightly as to obstruct the tripod legs being stretched.
3. Beginning with the first pole, slip the strong cord through the hole and tie a knot at one end of the cord leaving at least 100 mm of it hanging free.
4. Pull the remaining part of the rope until the knot you have made rests firmly against the pole, then measure off a distance of 600 mm and tie another knot and insert the rope through the hole of the second pole.

5. Repeat the same process with the third pole, always allowing a 600 mm length of rope as a distance between two poles. For the last length of rope, tie the two ends together and make sure that the length of cord between these two poles will be approximately 600 mm in length when the knot is completed.

6. Slip the wooden pegs through the holes at points A and B as shown in Fig. 2.

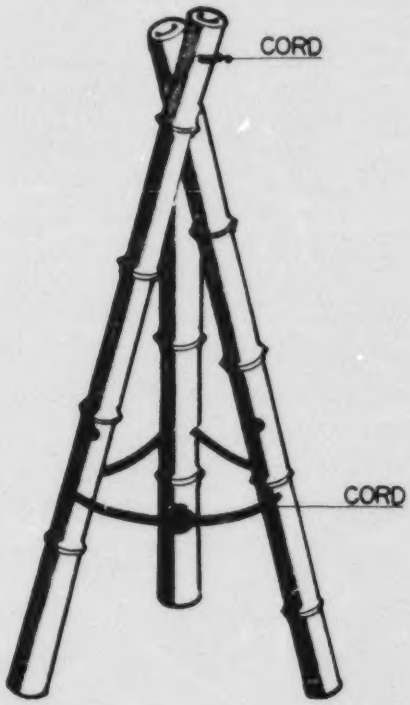


Fig.2

5. HOW TO USE

Set the tripod on a flat area, to support visual materials fixed on the pegs.

Source: Developed by the participants of the Republic of Laos, attending the Second Sub-regional Workshop on Educational Technology, Dacca, Bangladesh, November 1980.

FAN FACES FOR CONVERSATION DRILLS

Level: Primary and secondary
Subject area: Language subjects

1. BRIEF DESCRIPTION

In conversation drills, hand fan faces can be used for identification of the speakers involved in conversation.

2. OBJECTIVES

1. To assist the learners to distinguish each speaker.
2. To attract students' attention.
3. To make the conversation drills more interesting.

3. MATERIALS NEEDED

1. Used hand fans (two or more).
2. Several sheets of white paper (A 4 size).
3. Crayons or water colours and brush.

4. HOW TO MAKE

1. Draw various faces on the white paper and colour them.
2. Paste each face on a hand fan.
3. Cut out the outlines of the faces.

5. HOW TO USE

1. Give a name to each fan face.
2. Distribute the fan faces to the students involved in the conversation drill. Let them hold the fan faces upright.
3. Conduct the drill inviting each student with a name given in the conversation to take part in the conversation when his/her turn comes.

6. POSSIBLE MODIFICATIONS

Where used hand fans are not available, the students can produce their fan faces using cardboard and wooden sticks.

Source: Korean Educational Development Institute, Educational Resources Handbook for Primary Education, Seoul: KEDI, 1980.

SHEET 7

SIMPLE PUPPETS

Level: Primary
Subject area: Language and social studies

1. BRIEF DESCRIPTION

Puppets are instructional materials which can simulate real life situations and make lessons more interesting.

2. OBJECTIVES

1. To make the teaching/learning process interesting.
2. To promote creative ideas in teaching/learning moral education, language and social studies.

3. MATERIALS NEEDED

1. Wooden ball, 100 - 150 mm in diameter.
2. Coloured paper.
3. Cloth remnants in different colours.
4. Cardboard tube (core from toilet tissue paper).
5. Wooden pieces.

4. HOW TO MAKE

1. Cut off the bottom part of the ball and drill a hole large enough to put in a wooden neck so as to assemble the head and the body.
2. Glue the cloth remnants around the ball.
3. Decorate the face with glue, cloth remnants, bits of paper, thread and twigs.
4. Roll the cardboard as a tube with diameter about 30 mm or use a core from toilet tissue paper as the upper part of the body.
5. Attach cloth remnants at the lower part of the tube as a skirt.
6. Attach arms to the body.

5. HOW TO USE

In story telling, games and language classes, the appropriate puppet that would attract students interest and attention, may be displayed and moved around, according to the context of the lesson.

Source: Instruction sheet, developed by the Educational Technology and Innovations Centre, Department of Teacher Education, Bangkok, Thailand, 1980.

SYLLABLE COMBINING KIT

Level: Infant
Subject area: Syllable learning

1. BRIEF DESCRIPTION

This is a wooden box with two concentric circles (two round cardboard circles of different size) - Vowels and consonants are written around the cardboard circles and seen combined through the window on the front side of the box.

2. OBJECTIVES

1. To increase the interest and attention of the pupils in learning how to combine syllables, reading and pronouncing them.
2. To provide an aid that parents can also use to help their infants in learning to read and pronounce syllables.
3. To enable pupils to self-examine their skills to read and pronounce syllables.

3. MATERIALS NEEDED

1. Thin plywood for the box (3-5 mm thickness, sizes as indicated in Fig. 1; all dimensions - in mm).
2. Two cardboard circles (150 mm and 110 mm in radius, as indicated in Fig. 2) - Nails and two metal handles as shown in Fig. 2.
3. Colour paints and brush.

4. HOW TO MAKE

1. Make a box to the dimensions shown in Fig. 1.

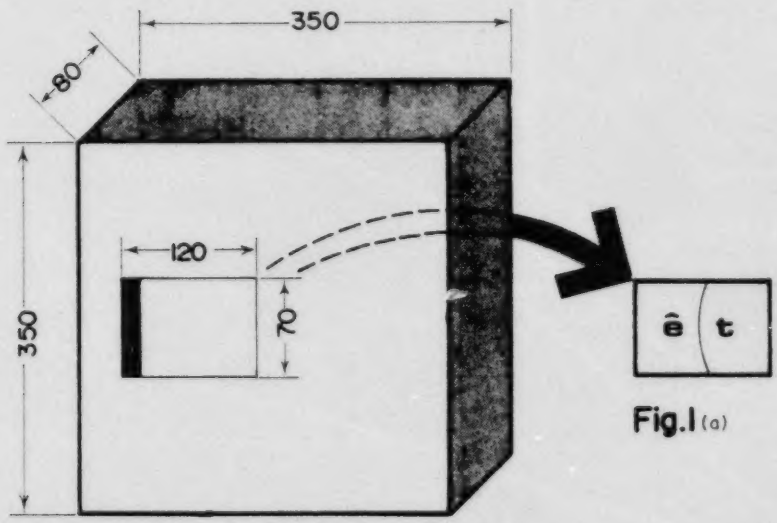


Fig.1 (a)

Fig.1 - FRONT

2. Cut a rectangular window (size 120 X 70 mm) on the front side. The back side is not covered.
3. Cut two cardboard circles with different radii (Fig. 2).
4. Write the vowels around the bigger circle, and the consonants around the smaller one, as illustrated in Fig. 2.

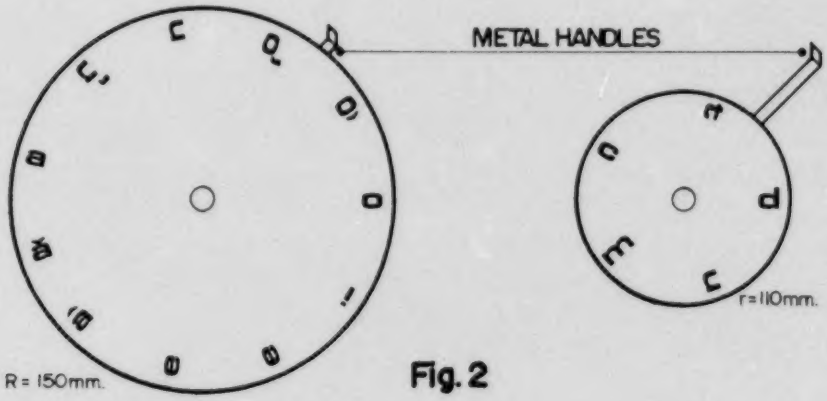


Fig. 2

5. Fix the metal handles to the cardboard circles to help turn them.
6. Fix the two cardboard circles in concentric position inside the box, at the front side, as illustrated in the rear view of the box (Fig. 3)

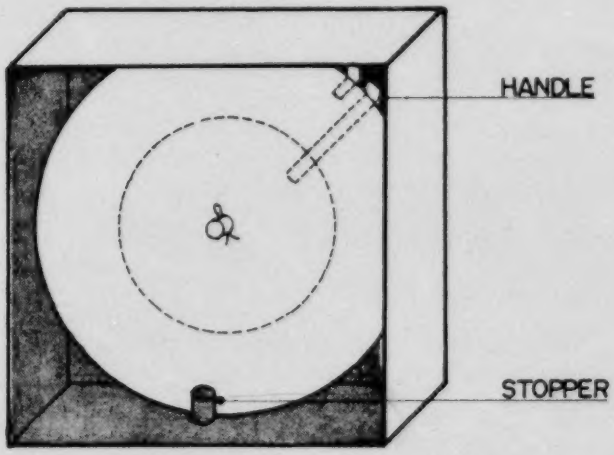


Fig. 3 - BACK

7. Fix a stopper that would hold one of the circles static while rotating the other circle as shown in the rear view of the box.

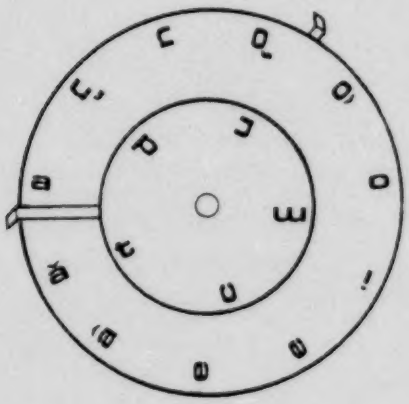
5. HOW TO USE

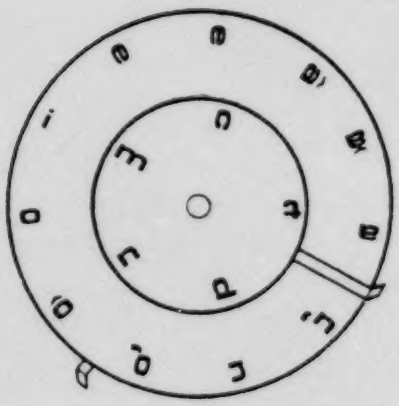
1. Fix the bigger circle in a static position so as to show a certain vowel through the window.
2. Rotate the smaller circle so as the combined syllable would appear through the window (Fig. 2).

6. POSSIBLE MODIFICATION

Fix the small cardboard circle so it is immobile and rotate the big one so as to produce various combinations.

Source: School Equipment Information, Department of School Equipment, Ministry of Education, Socialist Republic of Viet Nam.





QUESTION AND ANSWER WINDOW CARD

Level: Upper primary
Subject area: Language, social studies, science, health.

1. BRIEF DESCRIPTION

This simple self-answering card can be given to pupils to use on their own. The text is written on the front rectangular card and the questions and answers - on the circular card.

2. OBJECTIVES

1. To provide the pupils with self-correcting material that will free the teacher for other work.
2. To provide positive educational stimulus to the pupils by introducing an activity in which they have access to the correct answer at all times.

3. MATERIALS NEEDED

1. Sheet of card with dimensions about 420 mm x 150 mm.
2. Circular cardboard with diameter 160 mm.
3. Paper fastener.
4. Stapler or glue (optional).

4. HOW TO MAKE

1. Fold the rectangular sheet of cardboard in half as shown in Fig. 1.

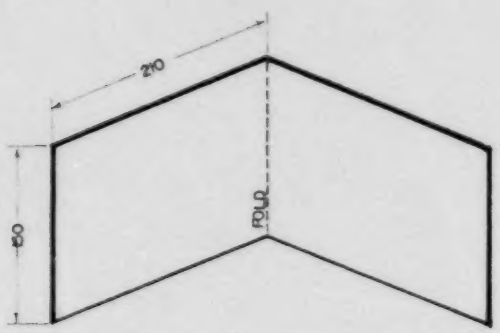


Fig. 1

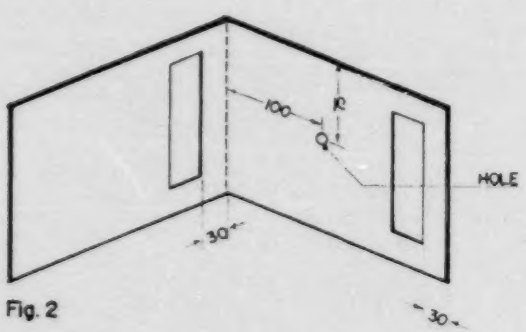


Fig. 2

2. Cut windows 80 mm X 20 mm and make a hole as shown in Fig. 2.

3. Draw a circle with radius 80 mm on another piece of cardboard, cut it out and punch a hole in the centre (Fig. 3).

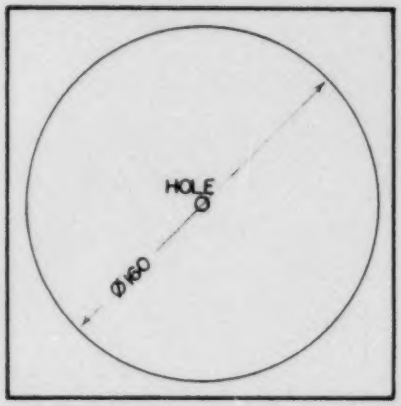


Fig. 3

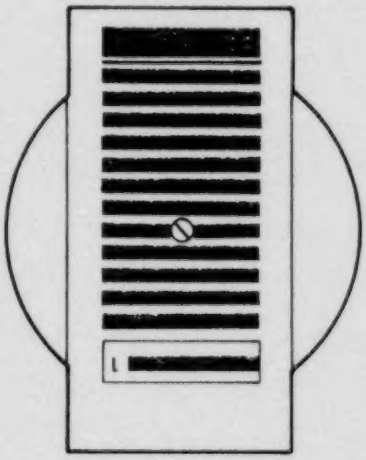


Fig. 4

4. Insert the cardboard circle between the sheets of the folded rectangular cardboard and fasten them through the holes with a paper fastener. You may staple or glue the bottom edges of the rectangular cardboard but this is not necessary.
Now write the text on the front of the card.

5. Write a series of questions through the window on to the circular card, moving the card round for each question. At the same time on the reverse side of the card fill the answer to each question. Be sure that answer number one is showing on the back when question number one is shown on the front.

5. HOW TO USE

This card can be used to revise work in almost any subject area. It may be a self contained article or can relate to additional text or diagrams studied earlier. It can be used for a simple folk tale or for a complex scientific principle.

Source: An Instruction Sheet developed by participants from Papua New Guinea at the Sub-regional Workshop on Educational Technology with Special Reference to Low-cost Educational Materials, Dacca, 27 October - 8 November 1980.

FLOOR PLANNING EXERCISE KIT

Level: Secondary school
Subject area: Industrial arts

1. BRIEF DESCRIPTION

When teaching the topic on floor planning in the Industrial Arts course, rectangular cardboard cut-outs of various sizes can be used to illustrate scaled-down shapes of rooms. These can be arranged in different combinations when designing a floor-plan. When a suitable floor plan has been designed it can then be depicted in drawings using architectural drawing techniques.

2. OBJECTIVES

1. To help the learners understand the basic considerations taken into account in the floor planning process.
2. To show that there are varieties of possible combinations when arranging rooms in a plan.
3. To help analyze the advantages and disadvantages of each floor arrangement attempted.

3. MATERIALS NEEDED

1. Cardboard, size 300 x 400 mm, thickness 1 to 2 mm.
2. A pair of scissors.
3. Pencil, eraser.
4. Ruler and a pair of set squares.

4. HOW TO MAKE

1. Draw the scaled-down shapes of the rooms needed for this exercise on a sheet of cardboard as shown in Fig. 1.

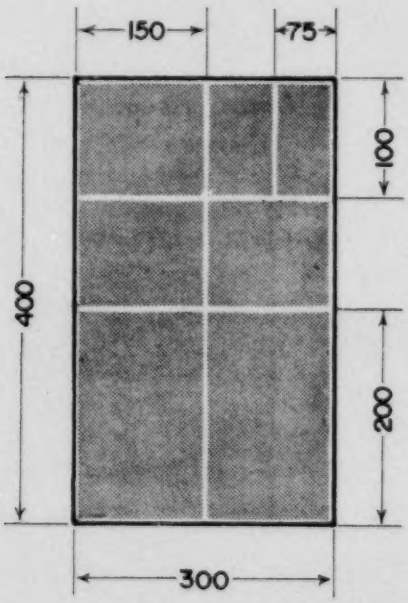


Fig. 1

2. Cut out the shapes drawn.
3. Give a name to each cutout, indicating its envisaged actual size according to the anticipated use of the premises, and label each cutout, as shown in Fig. 2.

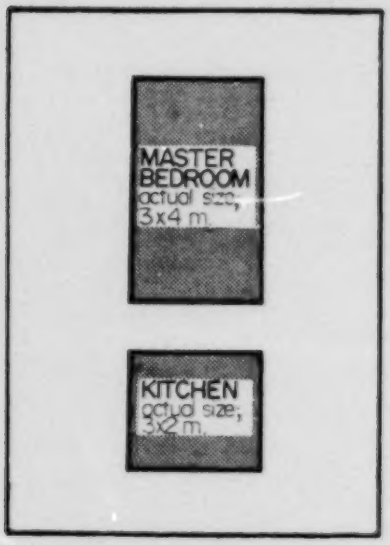


Fig. 2

5. HOW TO USE

1. Let the students arrange the cutouts in various combinations until they are satisfied with a floor plan.
2. Critically review the floor arrangement with students' interaction, employing question/answer techniques to provoke creative thinking.
3. Suggest improved re-arrangements.
4. Repeat 2 and 3 above until a satisfactory floor arrangement is achieved.
5. Request the students to transfer the floor arrangement onto a top-view drawing, employing the architectural drawing techniques.

Source: Korean Educational Development Institute, Educational Resources Handbook for Secondary Schools, Seoul: KEDI, 1980.

SHEET 11

PLAY-DOUGH (MODELLING CLAY)

Level: Infant and middle primary
Subject area: Craft, mathematics and science

1. BRIEF DESCRIPTION

This modelling clay can be used by children especially in the lower grades. They can produce all sorts of shapes and figures to help develop their imagination and creativity.

2. MATERIALS NEEDED

1. Two cups of plain flour.
2. Half cup of salt.
3. One and half tablespoons vegetable oil (e.g. peanut oil).
4. Half tablespoon of alum. (Alum may be bought from the chemist).
5. Food colouring.

3. HOW TO MAKE

1. Mix the above ingredients together in a bowl.
2. Add a few drops of food colouring to 3/4 cup of water.
3. Add this to the mixture, a little at a time, mixing the dough with your hands.
4. Continue adding the water until the dough is soft and flexible but not sticky.
5. This dough will remain soft and flexible provided that it is kept in a plastic bag.

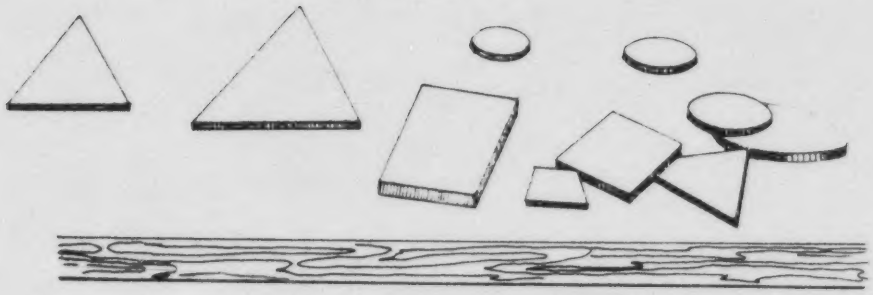
4. HOW TO USE

1. The prepared dough can be divided into four or six even parts among four or six pupils. If you have enough of the ingredients, you can prepare more for a class of 36 or different groups of children can have a turn of playing with the dough at different times.
2. Design the figures or shapes they should make to relate to some of your lessons, as for example:
   a) In mathematics: When learning about shapes the children can mould shapes with the dough, or they can make little figures when they are learning about numbers.
   b) In English language: They can make figures helping to practice their sentence patterns, e.g.: "This is Tom"; "This is a house", etc.

5. POSSIBLE MODIFICATIONS

1. If you live too far away from a chemist, you can do without the alum. This means that your dough won't keep as long as it would when mixed with alum.
2. You can also use natural colours instead of the food colouring substance from the shops.
3. If you don't have a tablespoon, use a teaspoon. One tablespoon = four teaspoons.

Source: Making and Using Low-cost Teaching Aids, report of a National Workshop, Port Moresby Teachers In-service College, Papua New Guinea, 28 April - 2 May 1980. Papua New Guinea Department of Education, 1980.



COCO-BUR PEGBOARD

Level: All levels
Subject area: All subjects

1. BRIEF DESCRIPTION

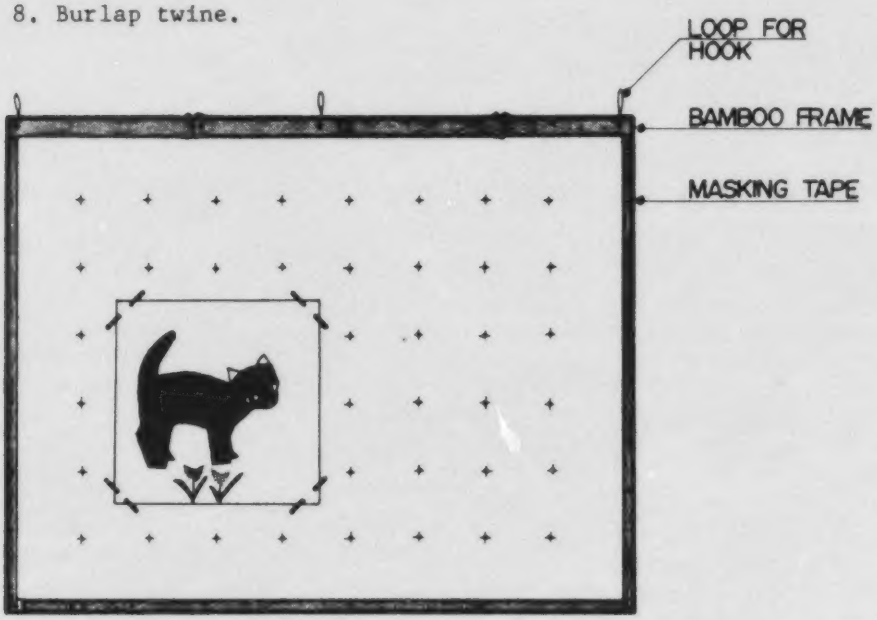
This is a low-cost pegboard made of shredded coconut husks covered with burlap sacks and prepared like a mattress. It can hold pictures, cutouts and strips using midribs or pointed sticks as pegs instead of pins, nails, or thumb tacks. It may be used for displaying visual aids in any subject area.

2. OBJECTIVES

1. To provide teachers and pupils with a handy material for presentation of visual aids.
2. To stimulate pupils' interest.
3. To make learning enjoyable.

3. MATERIALS NEEDED

1. Twenty or more pieces of matured coconut husks.
2. Two pieces of burlap sacks.
3. A bamboo splint with dimensions: 2.5 m X 20 mm X 10 mm.
4. Twenty or more bamboo pegs, 150 mm long.
5. A few wire frames.
6. A pair of scissors.
7. A large needle.
8. Burlap twine.



4. HOW TO MAKE

1. Open the seams of the two burlap sacks. Wash, dry and press them.
2. Skin the coconut husks. Pound and shred the husks. Dry them under the sun.
3. Lay one burlap sack on the table and spread on it the shredded husks evenly to the desired thickness for a mattress. Spread the other burlap sack to cover the layer of husks. Stitch the sides together. Make several running stitches across horizontally and vertically about 100 mm apart to hold the shredded husks in place when the pegboard is hung.
4. Bind the edges of three sides of the pegboard with masking tape.
5. The fourth side should be framed with a bamboo splint. Attach three loops or holders to this bamboo splint to hang the coco-bur pegboard on some hooks or nails on the chalkboard frame or a chart stand.

5. HOW TO USE

1. For demonstration lessons, hang the coco-bur pegboard on a chart stand or on the chalkboard frame. Use pegs to attach the pictures or number cards, or cutouts and strips as the presentation goes on. The materials to be pinned are provided with small holes, as big as the pointed pegs or midribs. For better hold, pin the visual materials diagonally.
2. For long-term display, pin the visual materials at two diagonally opposite corners.
3. When using cutouts on sticks in story-telling, lay the coco-bur pegboard flat on a table and stick the cutouts that depict the setting or illustrate the learning situation.

6. POSSIBLE MODIFICATIONS

1. As a substitute for a sandtable, you could make the mattress thicker by using more shredded husks.
2. Use plywood or woven split bamboo to frame the coco-bur pegboard.

Source: A Case Study on the Development of Low-cost Educational Materials in the Philippines, Ministry of Education and Culture, Manila, Philippines, 7 June 1980.*

*This particular teaching aid and instruction sheet were developed during a Seminar-Workshop on the Preparation of Support Instructional Materials for the EEEP, MEC, Region VIII, Tacloban City, 1 - 18 October 1979.

STRIKE A MATCHBOX

Level: Primary
Subject area: Basic arithmetic

1. BRIEF DESCRIPTION

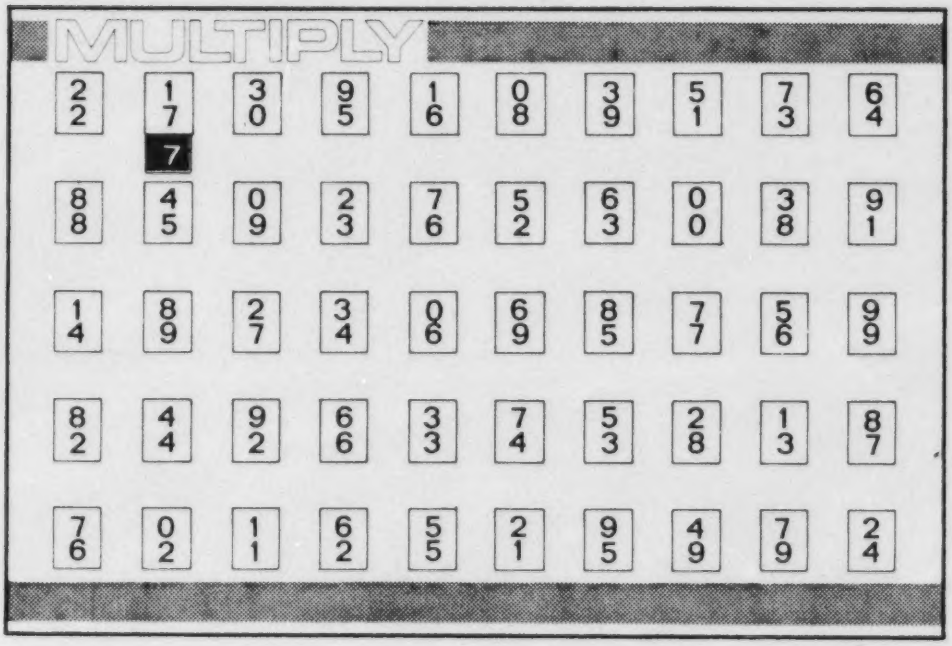
This device is made up of empty matchboxes on which multiplication combinations are written. Their corresponding products are written at the back side of the inner compartments which have been covered with yellow cardboard.

2. OBJECTIVES

1. To master the learning of the basic multiplication facts.
2. To solve multiplication combinations with speed and accuracy.
3. To develop honesty and alertness in checking answers.

3. MATERIALS NEEDED

1. Fifty empty matchboxes.
2. Corrugated cardboard.
3. Cardboard (green and yellow).
4. Sticks.
5. Glue.
6. Pentel pens (black and red).



4. HOW TO MAKE

1. Cut out 50 pieces of green cardboard the size of the face of a matchbox. Write a multiplication combination on the cardboard with black pentel pen. Glue the card on to the matchbox.
2. Cut out 50 pieces of yellow cardboard large enough to cover the outside face of the inner compartment of the matchbox. Write the corresponding product at the bottom of the cardboard with red pentel pen. Glue the card to the inner compartment.
3. Insert the inside compartment so that the bottom covered with yellow cardboard will be facing you when opened. (Do the same with all the other matchboxes).
4. Arrange the closed matchboxes on the corrugated board in five rows of 10 (See diagram). Glue them to the cardboard so that the multiplication combinations are showing.
5. Punch three holes along the top of the board (one in each corner and one in the middle) and hang it up.

5. HOW TO USE

Expose any row of the cards for drill purposes. Push each inside compartment with a pointed stick to expose the answer.

6. POSSIBLE MODIFICATIONS

1. In materials:
   a) Instead of writing the combinations on matchboxes, write them on the sheet of cardboard.
   b) Cut out a window below each combination.
   c) Attach another sheet of card, the same size, at the back of the first sheet by glueing or stapling at the sides only. Write the answers in each "window".
   d) Insert a third piece of cardboard in between the two boards to cover and uncover the answers when checking.
2. In use:

   This device may also be used in other subjects such as English and Pilipino where words may be placed inside the compartments instead of combinations and numerals.

Source: A Case Study on the Development of Low-cost Educational Materials in the Philippines, Ministry of Education and Culture, Manila, Philippines, 7 June 1980.*

*This particular teaching aid and instruction sheet were developed in a Seminar-Workshop on the Preparation of Support Instructional Materials for the EEEP, MEC, National Capital Region, Quezon City, Metro Manila, 17 February - 7 March 1980.

KNOW IT

Level: Primary
Subject area: Language

1. BRIEF DESCRIPTION

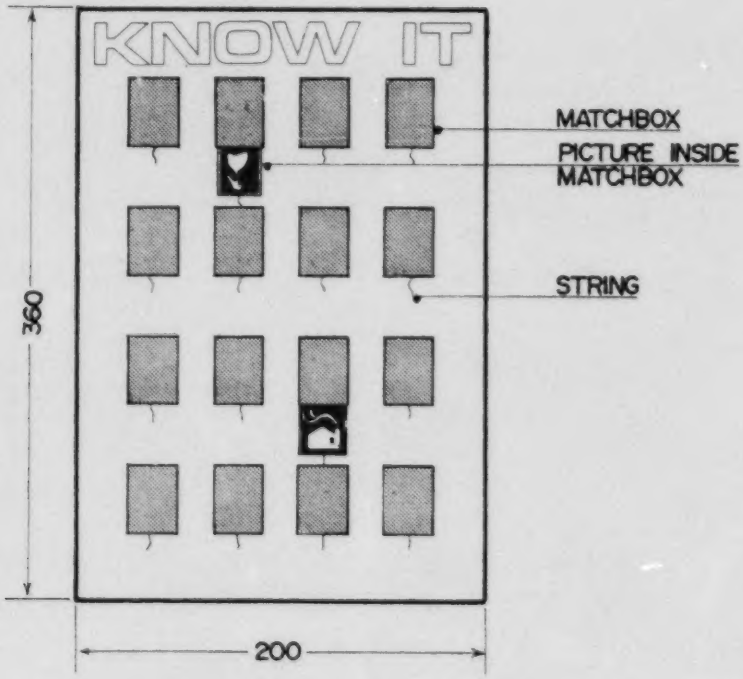
Matchboxes arranged in horizontal rows are pasted on a sheet of cardboard. A picture is pasted inside each matchbox. A string for pulling is attached to each container of the matchbox.

2. OBJECTIVES

To provide vocabulary enrichment activities.

3. MATERIALS NEEDED

1. Cardboard, 360 mm X 200 mm.
2. Coloured string.
3. Sixteen empty matchboxes.
4. Pictures.
5. Sticky tape.
6. Glue/paste.



4. HOW TO MAKE

1. Cut a piece of cardboard with dimensions 360 mm X 200 mm as a background on which to paste the matchboxes.

2. From old magazines, cut out pictures of community life, persons, events, etc.

3. Paste one picture inside each match container.

4. Attach an 80 mm long piece of string to each container. Use the string for pulling the matchbox.

5. Arrange and paste the 16 matchboxes in four rows on the cardboard.

5. HOW TO USE

1. Divide the class into two groups.

2. A member of one group pulls a string to show the picture inside the box. A member of the other group identifies the picture. The members of each group take turns pulling and identifying the pictures. The group that has identified the greatest number of pictures correctly, wins.

6. POSSIBLE MODIFICATIONS

1. Riddles instead of pictures may be placed inside the matchboxes.

2. The device may be used in other subject areas by changing the pictures or contents inside the matchboxes.

Source: A Case Study on the Development of Low-cost Educational Materials in the Philippines, Ministry of Education and Culture, Manila, Philippines, 7 June 1980.*

*This particular teaching aid and instruction sheet were developed during a Seminar-Workshop on the Preparation of Support Instructional Materials for the EEEP, MEC, Region X, Cagayan de Oro City, 11 - 30 November 1979.

SHEET 15

WORD-PICTURE BAMBOO TILES

Level: Infant and middle primary
Subject area: Language, mathematics

1. BRIEF DESCRIPTION

These are two sets of bamboo tiles or chips. Illustrations of common objects are drawn on one set of bamboo chips. Likewise the corresponding names of the objects are printed on the other set of bamboo chips.

2. OBJECTIVES

1. To provide enrichment and remedial activities for slow learners in the lower grades.
2. To make learning more meaningful and enjoyable.

3. MATERIALS NEEDED

1. Any number of pieces of bamboo chips with dimensions 60 mm X 40 mm.
2. Crayons or water colours.
3. Pentel pen.
4. Sandpaper.
5. Two empty shoeboxes.

4. HOW TO MAKE

1. Cut the bamboo sticks into pieces with dimensions 60 mm X 40 mm.
2. Smooth each piece with sandpaper.
3. Illustrate an object on one bamboo tile and on the other, print its corresponding name, thus forming a pair.
4. Do the same with the rest of the tiles.
5. Place the bamboo blocks with illustrations in one shoebox and those with printed words in the other box.

5. HOW TO USE

1. Divide the class into two groups for the activity. Group A is given the set with illustrations of objects while the other group is given the set with the printed names of the objects. A pupil from Group A stands and shows one tile to the other group. A member of Group B (with printed names of the objects) picks out the appropriate name-tile and matches it with the illustration.
2. The next move is for a member of Group B to present a tile with the name of an object and anyone in Group A picks out the illustration-tile which pairs with the word-tile.
3. The group that gets the most number of points in matching the pictures with the correct names, wins.

6. POSSIBLE MODIFICATIONS

1. In materials:
   a) Thick cardboard, plywood or pieces of thin cardboard cut uniformly may be used instead of the bamboo tiles.
   b) Some flat shells or wood blocks cut crosswise from branches of trees may serve as word or picture titles.
2. In use:
   a) The tiles may be used for matching antonyms, synonyms, or homonyms.
   b) Mathematical combinations may be printed and the corresponding answers to such combinations in place of illustrations and words.
   c) Exercises in science and health, music and other subject areas may make use of these bamboo chips.

Source: A Case Study on the Development of Low-cost Educational Materials in the Philippines, Ministry of Education and Culture, Manila, Philippines, 7 June 1980.*

*This particular teaching aid and instruction sheet were developed during a Seminar-Workshop on the Preparation of Support Instructional Materials for the EEEP, MEC, Region VI, Iloilo City, 5 - 23 September 1978.

BAMBOO COMPASS

Level: Primary and secondary
Subject area: All subjects

1. BRIEF DESCRIPTION

This bamboo compass is a classroom teaching instrument used to draw circles on the chalkboard. It has great utility value as it can be used in all grades for many subjects.

2. OBJECTIVES

1. To produce a teaching-learning instrument by using locally available materials.
2. To provide a simple instrument for classroom use and for out-of-the-classroom use.
3. To provide an instrument that will accurately draw circles on the chalkboard.

3. MATERIALS NEEDED

1. Two bamboo rods about 15 mm in diameter and 300 mm long.
2. Wooden peg 25 mm in length and a diameter that fits into the hole of the bamboo, with one end sharpened.
3. A bolt and a wing nut.
4. Two strong elastic bands.
5. One piece of chalk.

4. HOW TO MAKE

1. Make a slit 3 cm deep in one end of each rod (if the chalk and the wooden peg fit securely into the bamboo holes, this step is not necessary).
2. Fit a piece of chalk in the end of one of the rods and clamp it firmly with an elastic band.
3. Fit a sharpened wooden peg in the end of the other rod and fix it firmly with an elastic band.

4. At the other ends of both rods slice off 3/4 of the circumference to a depth of 30 mm, leaving thin end-pieces.
5. Drill holes in the protruding end-pieces and fasten them together with the bolt and wing nut.

5. HOW TO USE

When using this compass, loosen the wing nut and set the compass at a desired angle, then tighten the wing nut.

Source: An instruction sheet developed by the participants from Lao People's Democratic Republic to the Second APEID Sub-regional Workshop in Educational Technology with Special Reference to Development of Low-cost Educational Materials, Dacca, 27 October - 8 November 1980.

TRIANGLE

Level: Primary and secondary
Subject area: Mathematics

1. BRIEF DESCRIPTION

This is a device to demonstrate to the students that the sum of the internal angles of a triangle is equal to 180°.

2. OBJECTIVE

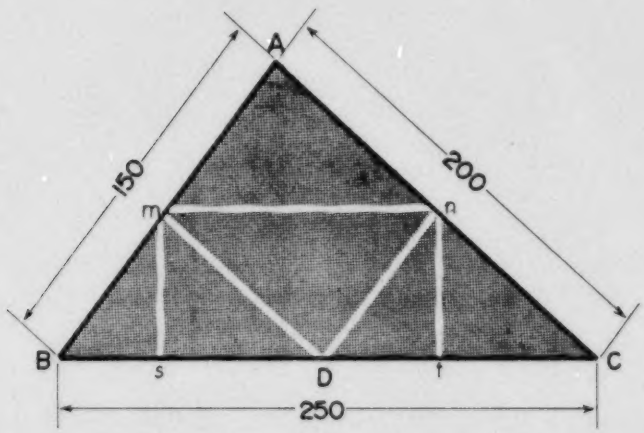
To develop the idea of one of properties of the triangle.

3. MATERIALS NEEDED

1. A piece of paper (size about 250 X 200 mm).
2. A pencil, a ruler and a pair of scissors.

4. HOW TO MAKE

1. Draw a triangle on a piece of paper and cut it out. The size of its sides could be, say, 250 mm, 200 mm and 150 mm.
2. Mark the angles A, B and C as shown in the diagram.



5. HOW TO USE

Fold the triangle along the lines mn, sm and nt so as to bring the three tips of the angles together to meet at point D. When the three angles A, B and C are thus brought together meeting at one point, their sum is equal to 180° (a straight angle). This method illustrates that the sum of the three angles of a triangle is equal to 180°.

Source: National Workshop on Low-cost Educational Materials, Dacca, January 1980.

MULTIPLICATION GAME

Level: Middle and upper primary
Subject area: Mathematics

1. BRIEF DESCRIPTION

"Multifact" is a game for up to four players. The game is designed to help the children in learning multiplication.

2. OBJECTIVES

1. To help the children learn multiplication facts.
2. To reinforce their multiplication skills.

3. MATERIALS NEEDED

1. Eight pieces of cardboard, size 280 mm X 280 mm.
2. Eight dice.
3. Thirty-two different coloured stones, shells, discarded bottle caps, etc.
4. Pencil and paper for each child.

4. HOW TO MAKE

1. Cut a piece of cardboard 280 mm square.
2. Divide into 100 small squares (28 mm X 28 mm).
3. Write the numbers from 1 to 100 on the squares consecutively.

5. HOW TO USE

1. Divide the class into eight groups of players.
2. Each group should have the following items:
   a) A multiplication board.
   b) A dice.
   c) Different coloured stomes, shells or discarded bottle tops.
   d) Pencils and Paper.
3. Each child in turn throws the dice until one gets a 6. That player starts.
4. Each child can continue throwing the dice in turn. The dice number tells how many spaces to move along the game board.

5. Suppose a player moves his/her stone to 12.
   That player must write down all the pairs of numbers
   that when multiplied will produce 12. He/she will write:

$$1 \times 12 = 12$$
$$2 \times 6 = 12$$
$$6 \times 2 = 12$$
$$3 \times 4 = 12$$
$$4 \times 3 = 12$$
$$12 \times 1 = 12$$

6. One point is given for each correct number sentence.

7. The player with the most points wins.

Source: Mathstok, Number 1, 1980. Maths Group Publication.
Department of Education, Papua New Guinea.

NUMBER JIG SAW PUZZLE

Level: Pre-school and infants
Subject area: Number

1. BRIEF DESCRIPTION

A simple jig saw puzzle for enhancing basic concepts of numbers while playing.

2. OBJECTIVE

To develop number concepts in pre-school children.

3. MATERIALS NEEDED

Ten pieces of 80 mm X 150 mm three-ply plywood, different colour paints and a brush.

4. HOW TO MAKE

On each of the pieces write a number on one side and draw pictures of some object to tally with the number on the other (Fig. 2). Now cut with a jig saw any pattern desired between the number and the pictures (Fig. 4). See that the patterns are different.

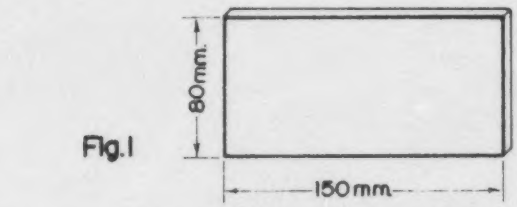


Fig.1

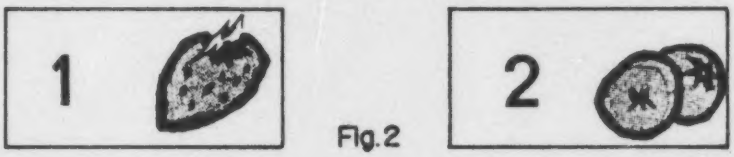


Fig.2

Fig.3

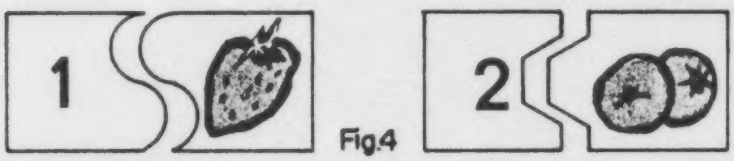


Fig.4

5. HOW TO USE

The children are given the jig saw pieces to play with.

Source: Second Sub-regional Workshop on Educational Technology, Dacca, Bangladesh, November 1980.

SHEET 20

SIMPLE DEVICE FOR MEASURING HEIGHTS

Level: Upper primary
Subject area: Mathematics

1. BRIEF DESCRIPTION

This is a very simple method of utilizing some basic knowledge in geometry in field conditions, when the access to a high point is difficult.

2. OBJECTIVES

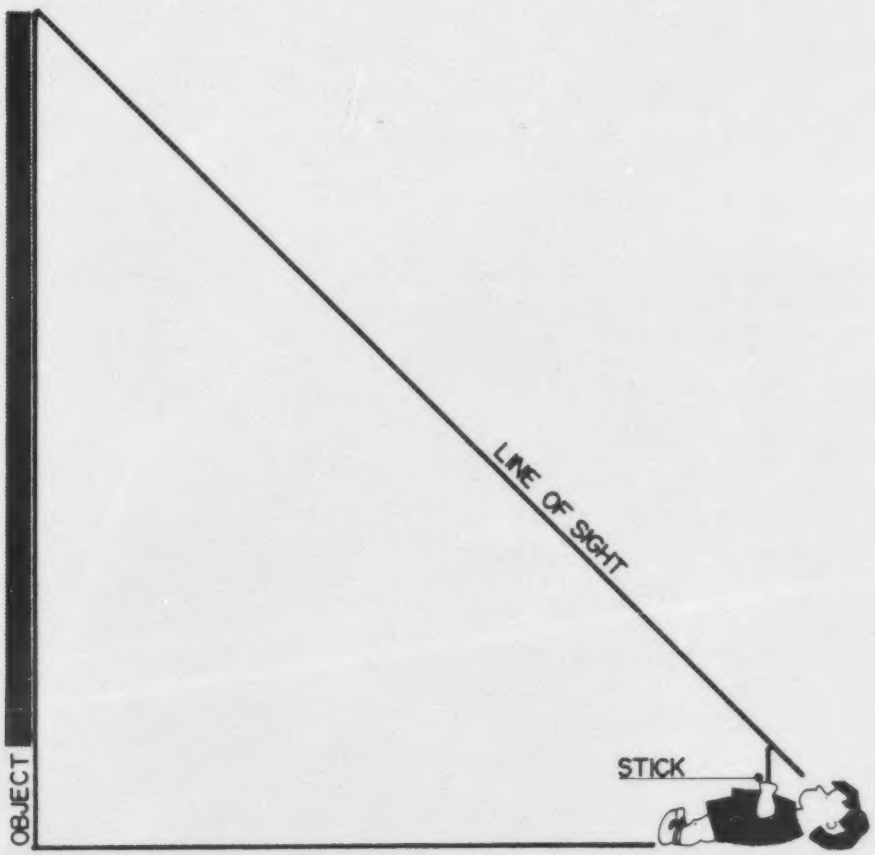
To estimate the height of trees, houses, poles, etc.

3. MATERIALS NEEDED

1. Measuring tape.
2. A straight wooden stick (or bamboo stick).
3. A knife.

4. HOW TO MAKE

Cut the stick with the knife, equal in length to the distance from your navel to your eyes.



5. HOW TO USE

1. Estimate the height of the object (e.g. a pole), whose height is to be determined.
2. Lie flat on your back at about the same distance from the pole as the estimated height of the pole, with your feet pointing towards it.
3. Hold the stick vertically on your navel.
4. Shift your position on the ground nearer to the object of farther from it, so that your eyes, the top of the stick and that of the pole are in line.
5. When this is achieved the height of the pole is approximately equal to the distance from the centre of its base to your eye or ear (because the angle subtended is 45°).
6. Get someone to measure the distance from the centre of the base of the pole to a mark beside your ear with the measuring tape. This gives the approximate height of the object.

6. PRECAUTIONS

1. The stick should be straight.
2. Do not breathe while aligning the top of the stick with the top of the object.

Source: Case Study on the Low-cost Appropriate Educational Materials and Development in India, Educational Technology Series Vol. No. IV, serial No. 1, 1980, Department of Teaching Aids, National Council of Educational Research and Training, New Delhi, India.

SHEET 21

GEOMETRICAL FIGURES AND SHAPES

Level: Primary
Subject area: Mathematics

1. BRIEF DESCRIPTION

This is a very simple method of demonstrating various geometrical figures.

2. OBJECTIVES

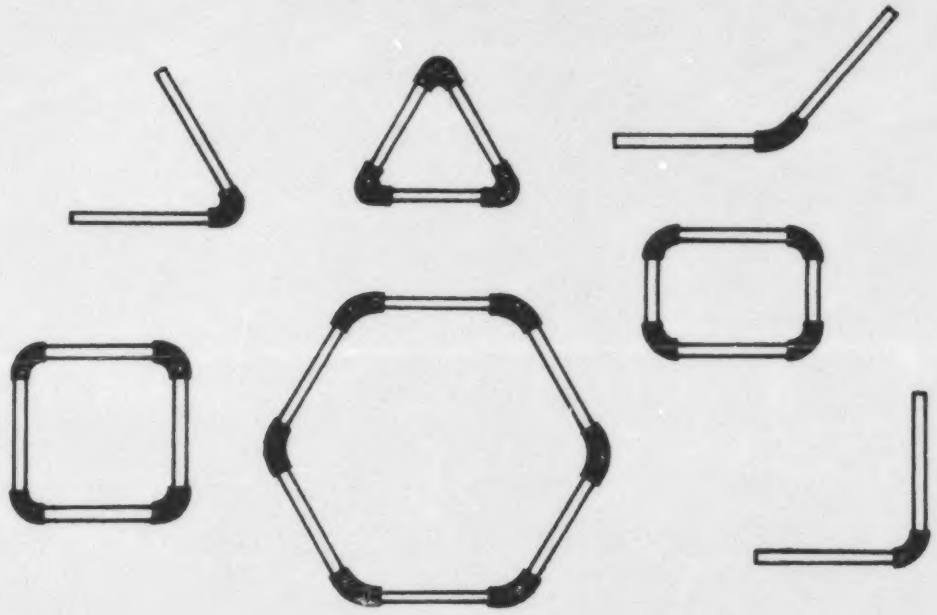
To aid children to learn about different geometrical shapes like triangles, squares, pentagons, and hexagons.

3. MATERIALS NEEDED

1. A box of match sticks.
2. 300 mm length of bicycle rubber valve tube.

4. HOW TO MAKE

1. Scrape the sulphur heads of the match sticks with a blade.
2. Cut 10 mm long pieces of the bicycle rubber valve tube.
3. Join the sticks with pieces of the rubber tube to produce various geometrical shapes.



Source: Case Study on the Low-cost Appropriate Educational Materials and Development in India, Educational Technology Series Vol. No. IV, serial No. 1, 1980, Department of Teaching Aids, National Council of Educational Research and Training, New Delhi, India.

RUBBER MODELS

Level: Pre-school and primary
Subject area: Hygiene and science

1. BRIEF DESCRIPTION

Rubber models are low-cost educational materials that can be easily produced in those areas of Asia and the Pacific where rubber is produced.

2. OBJECTIVE

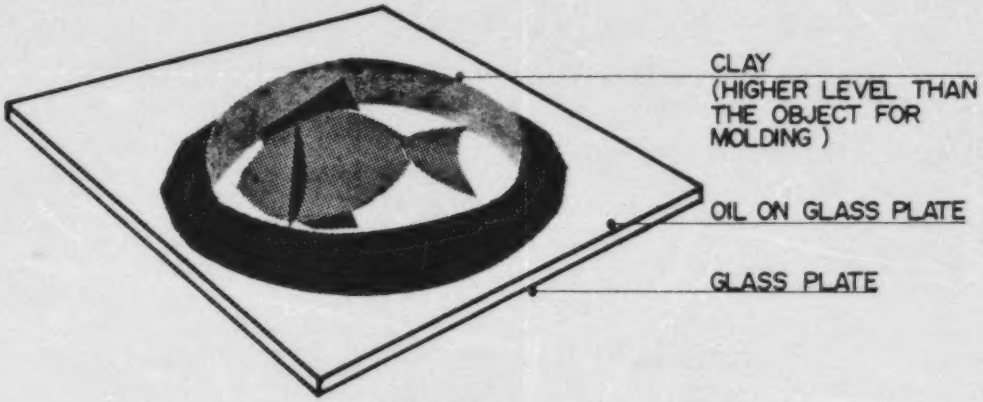
To produce rubber models as a substitute for other rare or expensive materials.

3. MATERIALS NEEDED

1. Prefabricated rubber juice mixture - ready for moulding (commercially available).
2. Gypsum plaster.
3. Clay.
4. An object to be used for moulding.
5. A glass plate or plywood about 500 X 500 mm in size.
6. A paint brush.
7. Coconut oil.
8. Water.
9. Cotton wool or fabric.
10. Linseed oil.
11. A piece of cardboard.

4. HOW TO MAKE

1. Oil the glass plate or plywood with coconut oil. Place the object for moulding on it.
2. Surround the object to be moulded by clay as shown in the picture.
3. Mix gypsum plaster with water by using one kilogram of gypsum plaster and one litre of water and pour it over the object to be moulded. When the plaster stiffens, turn the mould upside down and carefully remove the model from the plaster. The mould is ready.
4. Clean the mould by brushing every part of it with a paint brush. Use some cotton or fabric to wipe any water from the mould.
5. Pour rubber juice mixture into the mould. Oil the places which the rubber juice cannot reach easily, with cotton or a brush.
6. Leave the mixture in the mould for at least 24 hours.



7. Carefully remove the rubber model from the mould. Trim the rubber at the rim with a pair of scissors.
8. After trimming it, if the model is hollow, stuff it with cotton wool.
9. Use latex to glue the model to a piece of cardboard.
10. Paint it with enamel paint mixed with linseed oil.

Note: Do not use thinner because it dissolves the rubber.

5. HOW TO USE

The rubber models can be used as visual teaching aids in teaching hygiene, science and other subjects at pre-school and primary levels.

6. MODIFICATION

The model used for moulding might be a real object such as a dead frog, or fish, snake, etc. Remark: only hairless animals can be used. Besides these, some ready-made models such as models of artificial denture, ear, etc. can be used for moulding.

Source: An Instruction Sheet for Low-cost Educational Materials, prepared by Educational Innovations and Technology Centre, Department of Teacher Education, Bangkok, Thailand, 1980.

SHEET 23

KAI KAI MATCHING GAME

Level: Lower primary
Subject area: Health

1. BRIEF DESCRIPTION

The Kai Kai Matching game consists of a circular board and six packs of playing cards.

2. OBJECTIVES

1. To enable the children to recognize the different colours used to represent different food groups.
2. To reinforce the children's understanding of the need to select the right kind of food for their meals.
3. To show the children the importance of having a balanced diet.

3. MATERIALS NEEDED

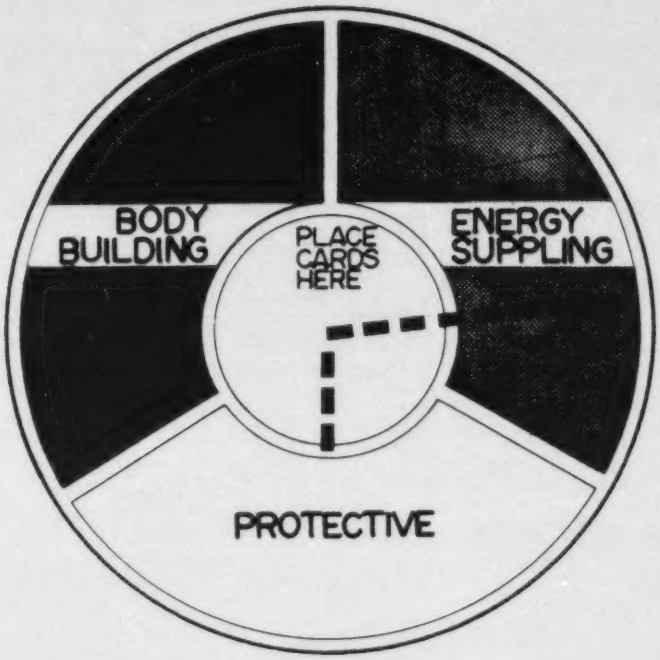
1. Cardboard.
2. A pair of scissors.
3. Six packs of 60 cards showing kinds of food from each group and coloured accordingly.
4. Six circular board of cardboard or plywood with diameter 500 mm.
5. Water colours and brush.

4. HOW TO MAKE

1. The board can be easily made from cardboard or plywood.
2. Divide the circular board into an inner circle and an outer circle consisting of three sectors, as shown in the illustration.
3. Each space of the outer part of the board can be coloured in the following manner: Body building food in red. Energy supplying food in yellow. Protective food in green.
4. The pictures on the playing cards are coloured according to their food group. The backs of the cards are not coloured.

5. HOW TO USE

1. Divide the class so as to form groups of three players for each circular board. If the number of circular boards and playing cards is not sufficient to occupy the whole class, the pupils could take turns in playing the game, and those not involved in playing could be 'observers' or occupied with another activity.
2. Each board is placed in the centre of the three players. Each one of the children can decide what to be. One can be 'red' (body building food), another to be 'yellow' (energy supplying food)and the other can be 'green' (protective food).
3. Place a pack of cards faced upside down on the inner circle.



4. Anyone of the players can start the game, standing (or seated) behind the coloured sector of the board, selected by the player.
5. The starter picks the card which is on the top of the pile and if it matches the colour of his/her sector then he/she places it face up, in his/her coloured region.
6. If the card a player takes does not belong to his/her region this card must be put back at the bottom of the pile in the centre.
7. The game ends when all the cards in the central circle have been used.

Note: At the end of the first game, the players can change colours and start playing again.

6. POSSIBLE MODIFICATIONS

At first it can be played so as to involve only colour matching.

Source: Making and Using Low-cost Teaching Aids, a Report of a National Workshop, Port Moresby Teachers In-service College, Papua New Guinea, 28 April - 2 May 1980. Papua New Guinea Department of Education, 1980.

SORTING GAME

Level: Primary
Subject area: Health

1. BRIEF DESCRIPTION

The sorting game consists of three large cardboard cards for the teacher and six packs of playing cards, called 'food cards'.

2. OBJECTIVES

1. To reinforce the children's knowledge of the three main food groups which are body building, protective and energy supplying.
2. To assist the children in learning to eat the right kind of food at the right time.
3. For enrichment of the learning process through correlating various activities such as reading, spelling, etc.

3. MATERIALS NEEDED

1. A sheet of cardboard to make the cards.
2. A pair of scissors.
3. Some coloured pencils, crayon, or water colours and brush.

4. HOW TO MAKE

1. Cut 360 smaller cards from cardboard, the size of ordinary playing cards, and prepare six packs of 60 cards each.
2. Draw one variety of food on each card as black line drawings and colour the back of the card according to the three main categories - green (for protective food), red (for body building food) and yellow (for energy supplying food).
3. Cut three separate larger cardboard sheets and print the names of the three food groups - energy supplying, body building and protective.

5. HOW TO USE

1. Divide the class into six teams with an even number of children in each team.
2. Give a pack of cards to each group.
3. Place the groups around a central area, each group apart from the others.
4. Ask the children to scatter the cards face up, making sure that the cards are not on top of each other and that no colours are showing.
5. Instruct the children to stand in a line in front of the scattered cards.
6. Explain to the class, that the three large separate sheets with the names of the three main food groups on them are for the teacher.

7. The teacher holds up a card with one of the names of the three main food groups. The first child of each team will race to pick out the food cards which belong to that food group. Each child who has completed a turn moves to the end of the line. The game continues this way till all the team members have had a turn.

8. At the end of the game, the teacher should see that no card has been misplaced, and award points to the team with no mistakes. The winning team is the one with the highest number of points.

Source: Making and Using Low-cost Teaching Aids, - report of a National Workshop, Port Moresby Teachers In-service College, Papua New Guinea, 28 April - 2 May 1980. Papua New Guinea Department of Education, 1980.

ROTATING SHAPES DEVICE

Level: Primary
Subject area: Science

1. BRIEF DESCRIPTION

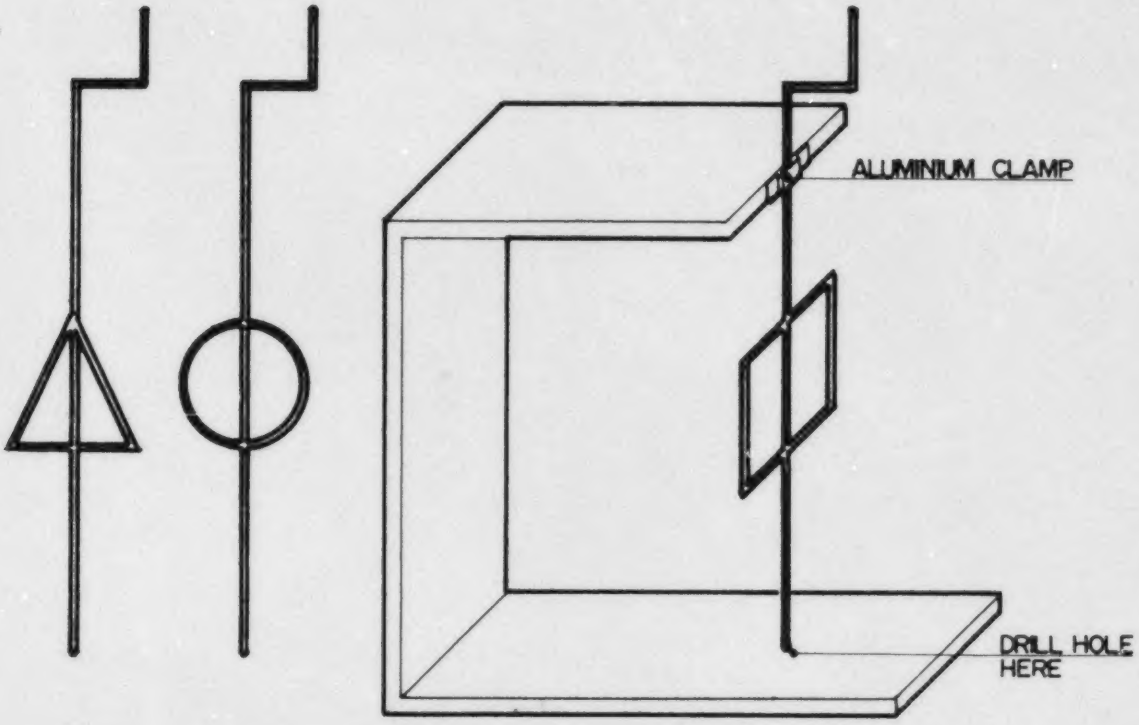
This is a rotary device which produces various three-dimensional images through the rotation of different flat shapes.

2. OBJECTIVE

To develop the ability to comprehend and visualize three-dimensional figures.

3. MATERIAL NEEDED

1. Wooden board with dimensions 200 mm X 80 mm X 20 mm (base).
2. Wooden board with dimensions 120 mm X 80 mm X 25 mm.
3. Wooden board with dimensions 120 mm X 80 mm X 20 mm (upper support).
4. Aluminium clamp with screws.
5. Galvanized iron wire, SWG 10.
6. Soldering iron, 100 watt.
7. "Fix-O-Fix" glue.
8. Metal file.



4. HOW TO MAKE

1. Assemble the three wooden blocks to make the stand.
2. Solder the galvanized iron wire forming the shapes of rectangle, circle and a triangle as shown in the figure.
3. Screw the Aluminium clamp at the centre of the top edge of the upper horizontal wooden board and drill a hole directly below it on the wooden base (see diagram).
4. Insert each wire model through the clamp by unscrewing one side of the clamp. Insert the lower end of the wire into the hole at the bottom.
5. The three-dimensional image can be created by rotating the handle at the top end of the wire.

5. HOW TO USE

Rotate the triangle, the rectangle and the circle, to produce a cone, a cylinder and a sphere.

Source: Case Study on the Low-cost Appropriate Educational Materials and Development in India, Educational Technology Series Vol. No. IV, serial No. 1, 1980, Department of Teaching Aids, National Council of Educational Research and Training, New Delhi, India.

CROVA'S DISC

Level: Lower secondary
Subject area: Science

1. BRIEF DESCRIPTION

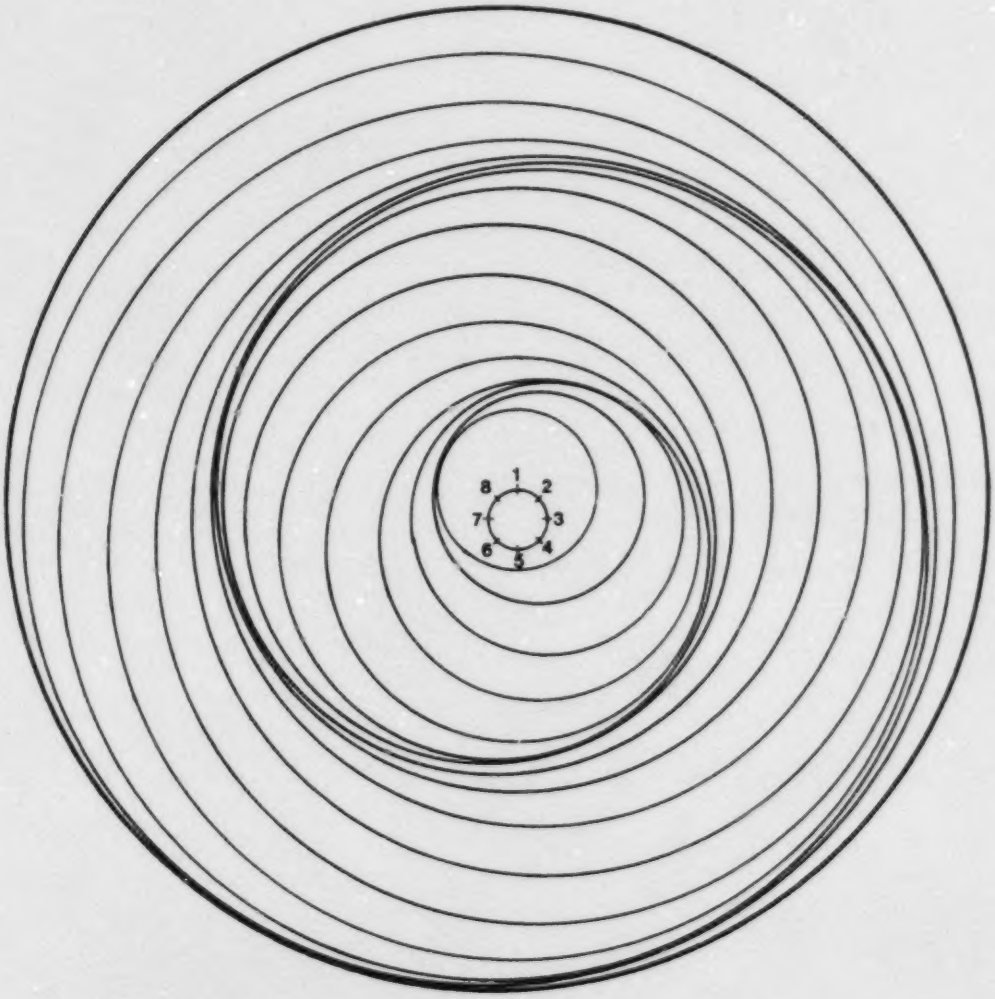
This is a very simple teaching aid for teaching basic science concepts.

2. OBJECTIVE

To demonstrate how the sound waves travel in air.

3. MATERIALS NEEDED

1. A piece of cardboard with dimensions 250 mm x 250 mm.
2. A compass.
3. A pencil.
4. A drinking straw.



4. HOW TO MAKE

1. Draw a circle in the middle of the cardboard with a radius of 4 mm.
2. Divide this circle into eight equal parts and number them from 1 to 8 as shown in the figure.
3. Place the compass point on mark No. 1 of the inner circle and draw a circle with a radius of 20 mm.
4. Place the compass point on mark No. 2 of the inner circle and draw a circle with a radius of 24 mm.
5. Continue drawing circles as above around the inner circle making the radius of each new circle 4 mm larger than the one before. Eight consecutive circles will thus be drawn.
6. Continue to draw circles around the inner circle for a second time, again making the radius of each new circle 4 mm larger than the one before.
7. One may continue for a third time also.
8. Now punch a hole in the centre of the disk to fit the diameter of a drinking straw, or other cylindrical shaft.

5. HOW TO USE

1. Insert the straw or the shaft in the central hole of the disk and spin.
2. The waves will be seen when the disk rotates.
3. Explain that as the sound wave propagates in air, there are regions formed called 'Condensations'.

6. POSSIBLE MODIFICATIONS

One may use a hand-drill to rotate the disk.

Source: Case Study on the Low-cost Appropriate Educational Materials and Development in India, Educational Technology Seires Vol. No. IV, serial No. 1, 1980, Department of Teaching Aids, National Council of Educational Research and Training, New Delhi, India.

SHEET 27

NEWTON'S DISC

Level: Lower secondary
Subject area: Science

1. BRIEF DESCRIPTION

This is a simple device for demonstrating the properties of light in basic science.

2. OBJECTIVE

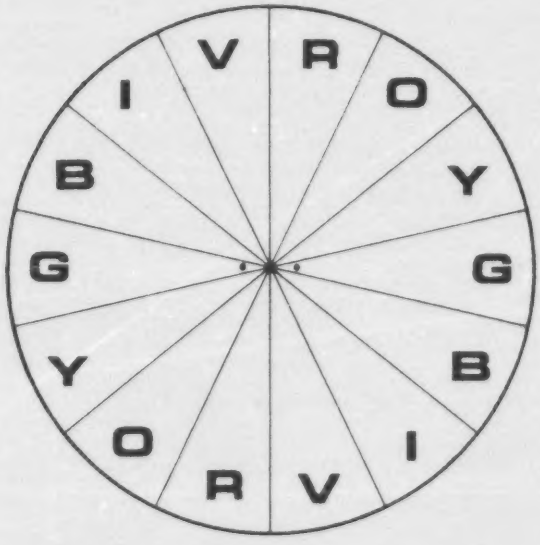
To demonstrate that light is composed of the seven colours of the rainbow.

3. MATERIALS USED

1. White circular cardboard piece with diameter 80 mm.
2. Water colours as indicated in the diagram: red, orange, yellow, green, blue, indigo, violet, (the colours of the rainbow).
3. Thread about 800 mm long.

4. HOW TO MAKE

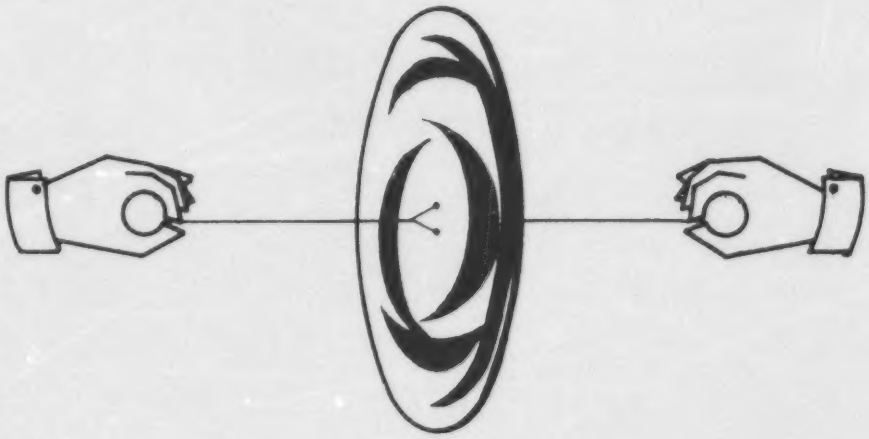
1. Divide one side of the disc into 14 equal sectors of about 26°.
2. Paint the seven colours of the rainbow in the right sequence in seven adjacent sectors and repeat the same colours again on the next seven parts as shown in the diagram. Make two holes near the centre of the disc, about 10 mm apart.
3. Pass two pieces of 400 mm long thread through these two holes.
4. Join their ends.



5. HOW TO USE

By rotating the disc the thread gets twisted. Pulling and releasing the thread alternately makes the disc rotate and twist the thread in the opposite direction. Repeating the process can make the disc rotate at a high speed.

The equal distribution of the seven colours, if repeated twice, would tend to produce nearly white colour when the disc is rapidly rotated. However, a more precise proportional area distribution of the seven colours, when the disc is divided into 14 sectors, is rather complex. At this early stage an equal distribution of the seven colours should suffice to demonstrate the idea.



6. MODIFICATION

1. The colour 'indigo' is slightly lighter than violet but darker than blue. Although it is not easily identifiable by the students nor readily available amongst their water colours especially in the village situations of India, it may be possible to use dark blue for indigo and sky blue for blue.
2. Children can paint two or three different colours on another disc and see the combination when mixed by rotation, such as: blue and yellow make green, red and yellow make orange, etc.

Source: Case Study on Low-cost Appropriate Educational Material and Development in India, Educational Technology Series Vol. No. IV, serial No. 1, 1980, Department of Teaching Aids, National Council of Educational Research and Training, New Delhi, India.

SHEET 28

HAND-HELD BAMBOO BALANCE

Level: Primary
Subject area: Mathematics

1. BRIEF DESCRIPTION

This is a simple and inexpensive device made of bamboo. It is useful in Community Schools for activities related to weighing.

2. OBJECTIVES

To understand the concept of weight and weight differences (light, heavy, equal in weight, heavier, lighter).

3. MATERIALS NEEDED

1. A bamboo stick (a piece between two joints, about 20 mm in diameter and about 280 mm long) for the beam of the balance. The bamboo should be of even thickness along its length.
2. A bamboo handle (should be about 100 mm long and 20 mm in diameter).
3. Two milk tin lids - 85 mm in diameter.
4. Six pieces of string - 200 mm each in length.

4. HOW TO MAKE

1. Clean the two pieces of bamboo.
2. Measure the length of the beam to find the centre. (Check the balancing of the beam on your finger). Then screw in three cup hooks (Fig. 1).
3. Fix the last cup hook to the handle (Fig. 2).

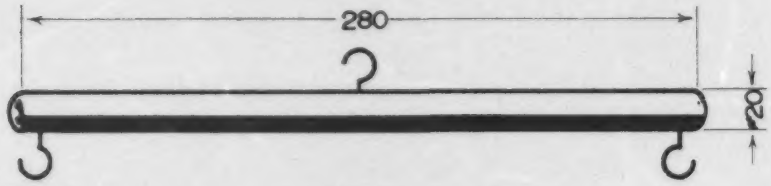


Fig. 1

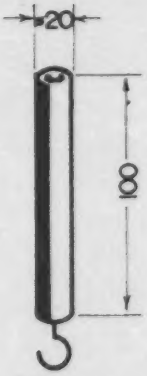


Fig. 2

4. Mark the edge of the milk tin lid dividing it into three equal parts. Punch holes with a 20 mm nail and small tack hammer where the marks are indicated.

5. Repeat the same procedure with the other lid.

6. Pass strings through the holes and knot the bottom ends. Tie the top ends together (Fig. 3). Do the same with the other lid.

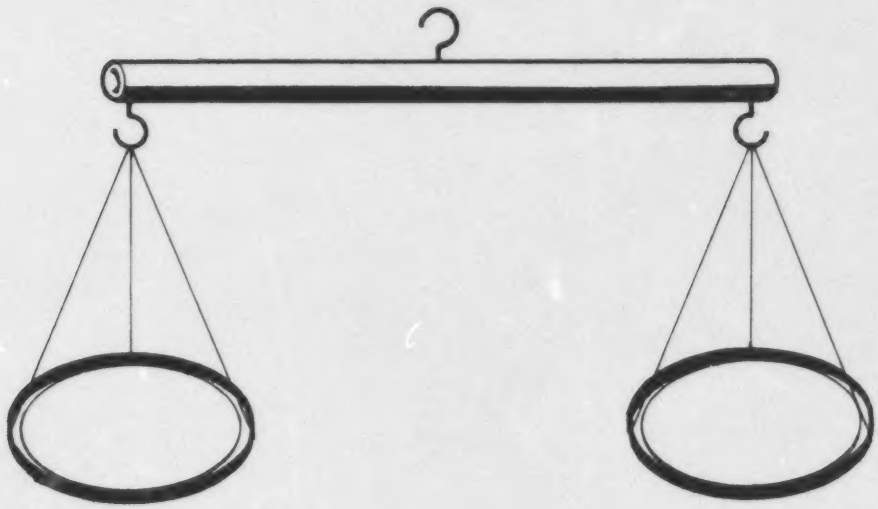


Fig. 3

5. HOW TO USE

1. Put the children into small groups of five. Group leaders will collect different objects for group activity.
2. The children will practice weighing different objects.
3. Encourage the children to identify the weight of the objects: whether they are light, heavy or equal in weight and to group them accordingly.
4. Children should verbalize the activity using phrases such as 'heavier than', 'lighter than', 'the same as'.

6. POSSIBLE MODIFICATIONS

1. Use dowelling or straight tree branches for beam and handle.
2. Instead of cup hooks, make holes thrugh the bamboo and thread wire to hold the pans.

Source: Report of a National Workshop, Port Moresby Teachers In-service College, Papua New Guinea, 28 April - 2 May 1980.

IMPROVISED SPRING BALANCE

Level: Primary
Subject area: Science, mathematics

1. BRIEF DESCRIPTION

This is a simple and inexpensive improvised spring balance. It consists of an elastic steel strip used as a pointer, a wooden support fixed to a wooden base, a paper scale, pasted on another wooden support and a conical paper pan hung on the steel strip.

2. OBJECTIVES

1. Measuring unknown weight.
2. Demonstrating the spring action.

3. MATERIALS USED

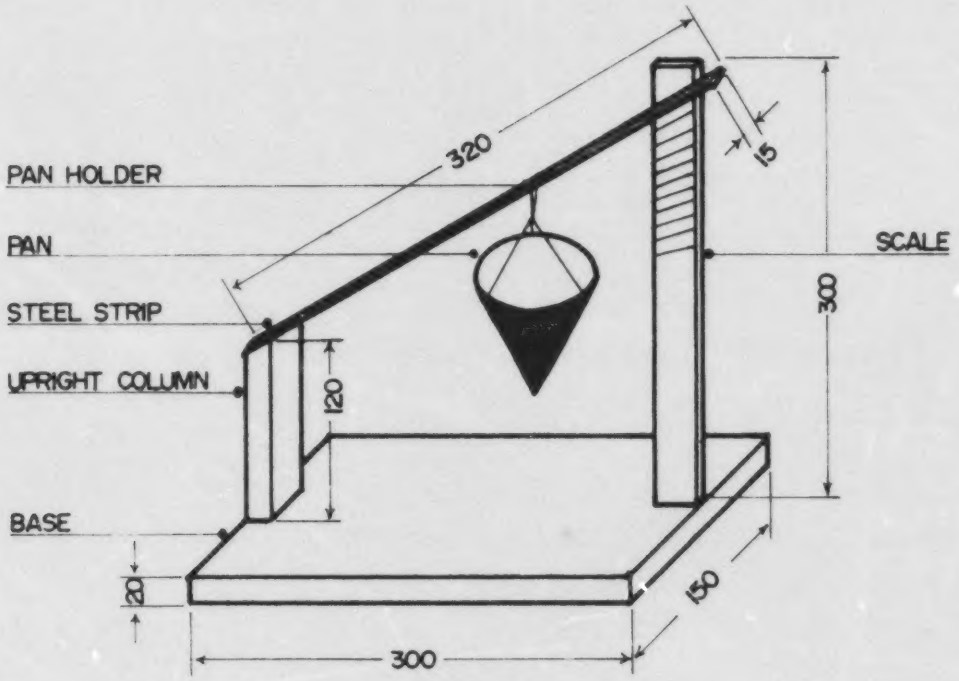
1. A piece of elastic steel strip (material with spring-action), about 320 mm long, 15 mm wide, e.g. an old saw reed.
2. Three pieces of wood: 300 mm X 150 mm X 20 mm
   300 mm X 30 mm X 10 mm
   120 mm X 30 mm X 20 mm (one end cut to an angle of 60^{o}).
3. A piece of tin sheet, 30 mm X 20 mm.
4. Iron wire (for making hook hanger).
5. Nails.
6. Glue.
7. Paper.

4. HOW TO MAKE

1. Using a piece of wood with dimensions 300 mm X 150 mm X 20 mm, as a base, nail the two wooden supports vertically as shown in the diagram.
2. Cut a strip of white paper 300 mm X 30 mm. Glue it to the wooden support as shown in the figure.
3. Nail one end of the steel strip on the shorter wooden support so the strip rests at an angle of inclination of about 60^{o}. The other end of the steel strip points against the paper glued to the longer wooden support, without touching it. When the end of the steel strip is pulled down, it should move along the vertical paper scale without touching it.
4. Make a conical pan using strong paper or tin sheet.
5. Make a circular hanger from iron wire of appropriate diameter to keep the paper pan suspended from the steel strip. To do this, bend the iron wire in the form of a circle of appropriate diameter. Fix the ends of three

short pieces of wire at three evenly spaced points of the circumference of the circle. Take the other ends of these three short wires together, twist them and then bend this end in the shape of a hook.

6. Suspend the hanger from the steel strip. Place the paper-cone pan inside the circular wire hanger.



5. HOW TO USE

1. Suspend the pan hanger, with the paper-cone pan inside it, at a suitable position on the steel strip with spring-action.
2. The improvised spring balance is now ready for use. However, to use it for measuring unknown weight, the balance has to be calibrated first, in the following way:
   a) Mark the 'zero weight' position on the paper against the end of the steel strip.
   b) Place different, known weights in the paper-cone pan in steps and in gradually increasing order in the pan and mark the paper accordingly against the steel strip end, writing down the weight values.
   c) Take out the known weights from the pan.
   d) The balance is thus calibrated with the paper scale indicating different weights. It is now ready for

measuring unknown weights within the range of calibration. Once the balance is calibrated for a particular position of the pan hanger on the steel strip, do not move the hook.

3. Now to measure an unknown weight, place it in the paper-cone pan. Let the steel strip come to rest, with its end pointing against the calibrated paper scale. Read the weight value from the paper scale calibrated previously in terms of known weights. Eye estimation may be used for reading fractions of weights between the scale marks but take care to avoid parallax error.

6. POSSIBLE MODIFICATION

By adjusting the position of the pan hanger on the steel strip the range of calibration can be increased or decreased.

Note: With any readjustment of the hanging pan, remember that:

- After displacement of the pan hanger the balance will need new calibration of the paper scale, using known weights.
- For a new calibration remove the used paper scale and glue fresh strip of paper.

Source: Developed at the National Workshop on Low-cost Educational Materials held at Dacca in January 1980.

SHEET 30

SPRING PENDULUM

Level: Secondary
Subject area: Physics

1. BRIEF DESCRIPTION

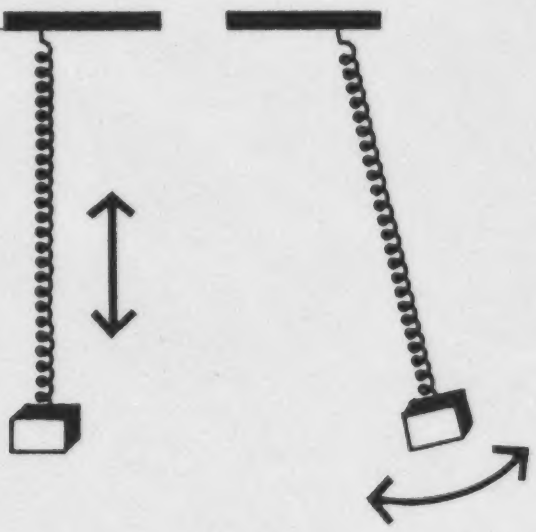
This is a simple teaching aid for demonstration in basic science (physics).

2. OBJECTIVE

To demonstrate how the energy is transferred from one mode to another.

3. MATERIALS NEEDED

1. A long stiff spring.
2. A pendulum bob.



4. HOW TO MAKE

Hook the spring and the bob attached to it and the spring pendulum is ready for demonstration.

5. HOW TO USE

1. Demonstrate that there are two modes of oscillation and explain that the energy is transferred from vertical mode of oscillation to horizontal mode and vice versa.
2. Show how the energy is being transferred from one mode to another mode of oscillation:
   a) A vertical pull sets up vertical oscillations but soon the vertical motion dies away and the bob begins to swing like a pendulum.
   b) After a short time, it is again oscillating vertically.

Source: Case Study on the Low-cost Appropriate Educational Materials and Development in India, Educational Technology Series Vol. No. IV, serial No. 1, 1980, Department of Teaching Aids, National Council of Educational Research and Training, New Delhi, India.

SHEET 31

CONSERVATION OF MOMENTUM AND ENERGY

Level: Secondary
Subject area: Physics

1. BRIEF DESCRIPTION

This is a simple device for demonstrating the physics laws in teaching science.

2. OBJECTIVE

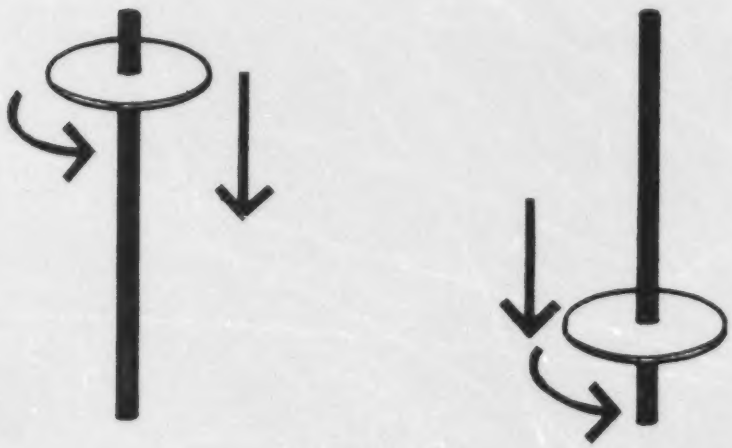
To demonstrate that the sum of potential energy, kinetic energy and the rotational energy always remains constant.

3. MATERIALS NEEDED

1. A cylindrical stick, one metre long, with even thickness and smooth surface.
2. A few circular pieces of cardboard.

4. HOW TO MAKE

1. Make a cardboard circular disc with relatively large diameter.
2. Punch a hole in the centre of the disc, with diameter slightly bigger than the diameter of the stick.
3. Insert the stick through the hole of the disc.



5. HOW TO USE

1. Hold the stick vertically and set the disc spinning by a flick of the fingers.
2. The disc will begin to drop much slower than one would expect and as it comes down the stick, the disc spins faster and falls even slower. Keep the stick immobile.

3. By inverting the stick just before the disc reaches its lower end, the process can be repeated continuously.

4. Explain to the pupils, that the gravitational field of the earth exerts a torque on the spinning disc causing it to rotate faster and faster. The initial potential energy gets transformed into kinetic energy.

Source: Case Study on the Low-cost Appropriate Educational Materials and Development in India, Educational Technology Series Vol. No. IV, serial No. 1, 1980, Department of Teaching Aids, National Council of Educational Research and Training, New Delhi, India.

CONVERSION OF POTENTIAL ENERGY INTO KINETIC ENERGY

Level: Secondary and primary
Subject area: Physics

1. BRIEF DESCRIPTION

This simple teaching aid is useful for demonstrating physics laws.

2. OBJECTIVE

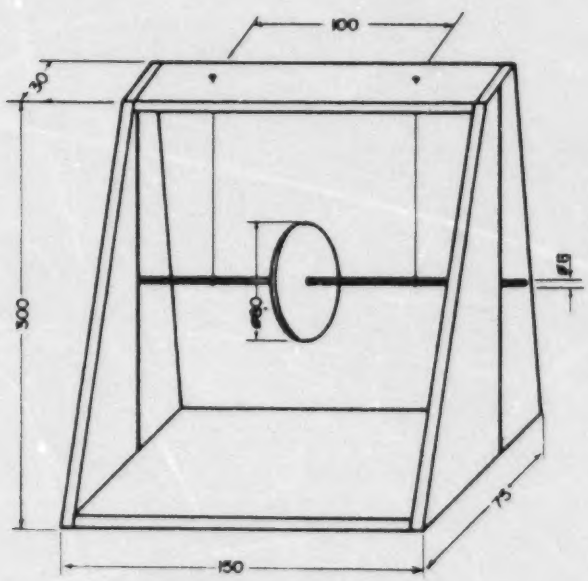
To demonstrate in a simple form the conversion of potential energy into kinetic energy.

3. MATERIALS NEEDED

1. Two 6 mm thick plywood slotted sides with dimensions 300 mm, 75 mm, and 30 mm, as shown in the diagram.
2. One 13 mm thick plywood base with dimensions 100 mm X 75 mm.
3. One 13 mm thick plywood top with dimensions 100 mm X 30 mm.
4. One 13 mm thick plywood circular disc with 80 mm diameter.
5. A piece of galvanized iron wire with diameter 100 mm and length 200 mm.
6. Two pieces of strong thread (string).

4. HOW TO MAKE

1. Assemble the slotted plywood side pieces with the base and the top as shown in the illustration.



2. Drill two holes along the central line of the top board for suspending the thread wound around the galvanized iron wire.

3. Fix loosely the circular disc to the iron wire, insert the wire through the vertical slots of the side walls and tie the two threads on both sides of the disc.

5. HOW TO USE

Wind the two strings uniformly by rotating the wire and disc until it reaches the top position.

The Potential Energy of the wheel converts into Kinetic Energy as it descends and the strings unwind. Again at the lowest position, it winds in the other direction and the wheel moves up.

Source: Case Study on the Low-cost Appropriate Educational Materials and Development in India, Educational Technology Series Vol. No. IV, serial No. 1, 1980, Department of Teaching Aids, National Council of Educational Research and Training, New Delhi, India.

STEAM TURBINE

Level: Lower secondary
Subject area: Physics

1. BRIEF DESCRIPTION

The steam turbine is a simplified model consisting of a closed cylindrical tin can, with a fine hole at the centre of the top and a small turbine wheel made from thin cardboard sheets fixed to bottle cork through which a bicycle spike is inserted and resting on two supports as shown.

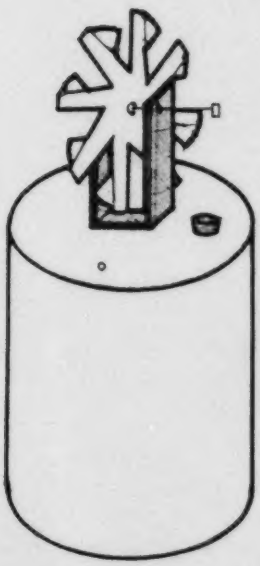


Fig. 1

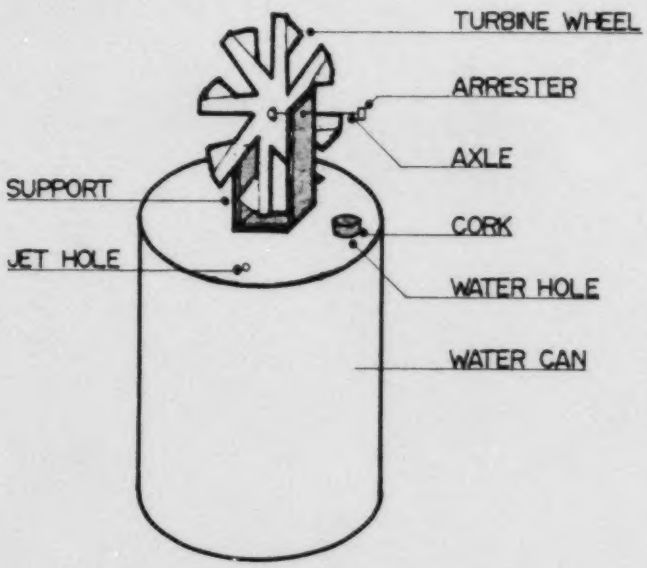


Fig. 2

2. OBJECTIVES

The main objective is to demonstrate to the students that when a certain volume of fluid is heated to a high temperature, and its pressure increases, this pressure can be put to work. The steam generated from boiling water can do work by rotating the wheel.

3. MATERIALS NEEDED

1. A cylindrical tin can, with tight-fitting lid and flat bottom, about 180 mm in height and 80 mm in diameter.
2. A bottle cork which is slotted to accommodate the cardboard wings.
3. Cardboard wings.
4. A bicycle spike.
5. A sheetmetal U-shaped support.

6. A candle or a spirit lamp - to be placed under the tin can.

7. A support for the tin can above the flame.

4. HOW TO MAKE

1. Drill a hole, 12 mm in diameter, in the lid of the can. The edge of the hole should preferably be at least at a distance of 6 mm away from the rim of the lid. This hole is used for pouring water into the can or draining it out.

2. Bend the 130 mm long tin strip in "U" shape with 25 mm for the horizontal part between the two vertical parts, which are 50 mm each.

3. Drill two holes with diameters slightly larger than the diameter of the axle of the turbine at the ends of the two arms of the bent U-shaped tin strip at a distance of 12 mm from the ends. In this case the 36 mm long, 2.5 mm or 1.5 mm diameter straight strong metal wire acts as the axle of the turbine.

   The diameter of the holes should be slightly larger than that of the axle to ensure free rotation of the axle. The holes in the strips should be made at such height that the turbine wheel is held between the two supports at a height between 6 mm to 12 mm above the jet hole.

4. Solder the U-shaped bent tin strip to the lid of the can so that the centre of its base arm lies exactly at the centre of the lid.

5. Fix the lid tightly over the mouth of the can. Solder the lid to the can around its edges to ensure that the steam is kept inside the lid, and that the lid is not blown off the can by the high pressure of the steam generated inside the can when water is boiled. Drill a hole of 1.5 mm diameter at a distance of 16 mm from the centre of the lid to act as the jet hole for the steam.

6. Make the turbine wheel through the following steps:

   a) Draw a circle with diameter 50 mm on the square-shaped thin tin sheet.

   b) Draw four diameters on the circle at 45°, so as to divide the circle into eight equal sectors.

   c) Drill a hole in the centre of the tin disc, with diameter slightly bigger than the diameter of the turbine axle.

   d) Cut the tin sheet around the circumference of the circle drawn with a metal-cutting scissor.

   e) Cut the tin disc along the eight radii drawn, 20 mm deep from the edge of the disc.

   f) Twist the partially cut sectors of the tin disc so as to form a turbine wheel as shown in Fig. 3.

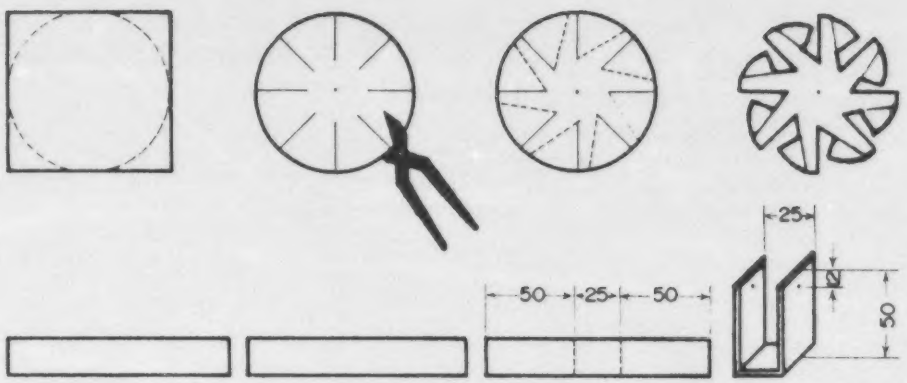


Fig. 3

7. Insert the axle through the central hole in the turbine wheel, so that the turbine wheel rests at the middle of the axle. Solder the turbine wheel to the axle to ensure that the turbine is rigidly fixed to it. Alternatively, insert the two tiny (5 mm long, 5 mm wide, 12 mm thick), solid rubber pieces, with tight-fitting holes in their centres, one through each end of the axle and press them against the two sides of the turbine wheel to prevent its axial movement.

8. Insert the two ends of the axle of the turbine through the holes in the two parallel vertical supports. Make sure that the turbine wheel rests straight above the jet hole drilled in the lid of the closed can.

9. Fix the two rubber stoppers at the two ends of the turbine axle and force them into positions very near to the outer sides of the two supports. These two tiny rubber pieces prevent the axial movement of the turbine axle.

5. HOW TO USE

1. Adjust the axle and the turbine wheel so that the turbine vanes rest above the jet hole.

2. Pour water into the can through the water-inlet hole and fill it up to two thirds of its volume. Close the water-inlet hole tightly with a rubber stopper.

3. Take a tripod stand and place the can, carrying the turbine as it is filled with water, on the tripod stand.

4. Heat the water in the can by means of a gas burner or a kerosene burner.

5. After a few minutes the water will boil, steam will be produced inside the can and with accumulated high pressure will escape from the can through the jet hole on the lid of the can, and below the turbine vanes, in the form of a jet. The escaping jet stream of steam under high-pressure will strike the vanes of the turbine with great force. This

will cause the turbine to rotate at high speed. The greater the pressure of the steam and the volume of the escaping jet of steam, the greater will be the speed of rotation of the turbine.

6. The speed of rotation can be controlled by regulating the heating, and the reduced temperature causes a corresponding reduction in the volume of the escaping jet of steam.

Source: Development of Low-cost Educational Materials, report of National Workshop on Educational Technology, Dacca, 21 - 27 January 1980.

COMMON PUMP

Level: Secondary
Subject area: Physics

1. BRIEF DESCRIPTION

This is a home-made model of a 'common pump' suitable for classroom demonstration in physics. The common pump is a device which transfers fluids from a region of higher pressure to a region of lower pressure.

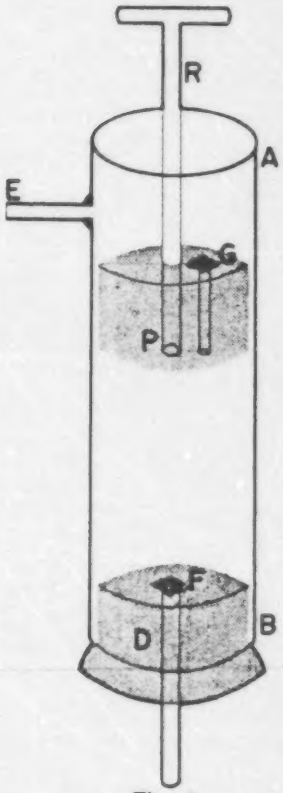


Fig. 1

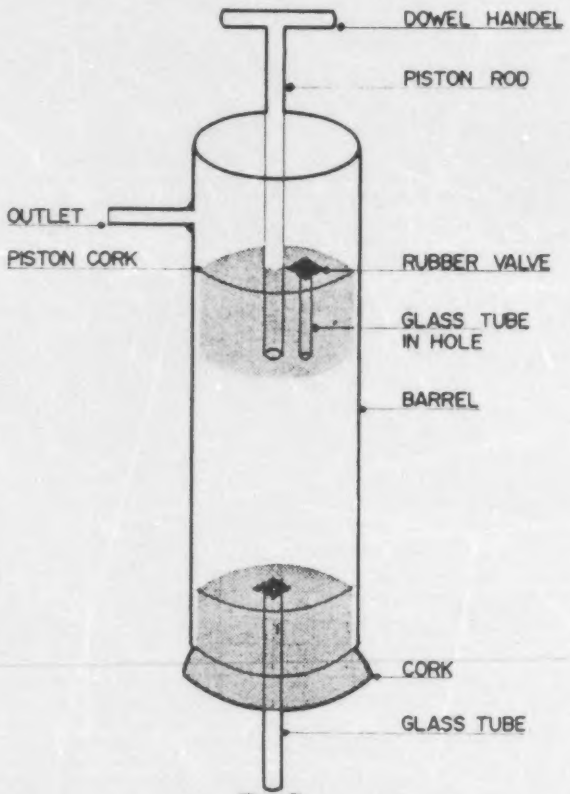


Fig. 2

Look at Fig. 1 and Fig. 2. The pump consists of a clear plastic tube AB (marked in Fig. 1), which is called the 'barrel' within which a piston P moves smoothly. The bottom opening of the barrel is fitted with a hollow rubber stopper D which has a small rubber flap valve F, opening upwards above the hole and a long glass tube inserted in the hole at the bottom. Near the top of the barrel there is a spout E consisting of a glass tube inserted in the hole drilled on the side of the plastic barrel and anchored in place by a rubber gasket. The top end of the plastic barrel is fitted with a hollow rubber stopper through which passes the piston rod R. (The upper rubber stopper is not shown in the drawing).

The piston consists of a rubber stopper C fitted to the metal rod with a dowel handle H. This rubber stopper has a hole, covered at the top by a small rubber fly valve G, opening upwards.

2. OBJECTIVES

With the common pump it can be demonstrated that the atmospheric pressure forces fluids to move from regions of higher pressure to regions of lower pressure, that it can raise water to a certain height, and that fluid pressure forces fluids to move from regions of higher pressure to regions of lower pressure.

3. MATERIALS NEEDED

1. Clear plastic tube, 300 mm long, with internal diameter 36 mm.
2. One soft rubber stopper 35.5 mm diameter, minimum 20 mm high.
3. Two soft rubber stoppers with diameter 36 mm and 16 mm high.
4. Two flaps of rubber sheet 1 mm thick, with dimensions 25 mm X 25 mm.
5. Iron piston rod, 5 mm diameter, 350 mm long.
6. Dowel handle, wood, appropriate size.
7. Three pieces of glass tube, with diameter 8 mm: one piece 200 mm long, one piece 150 mm long, and one piece 20 mm long.
8. Four sets of screws and nuts, 3 mm diameter, 24 mm long.
9. Four jam nuts, 5 mm diameter to fix the piston and the handle.
10. Rubber gum.

4. HOW TO MAKE

1. Cut the 35.5 mm diameter soft rubber stopper with a sharp knife to a length of 20 mm measuring from the top surface and also the two other stoppers with diameter 36 mm - to a length of 16 mm each.
2. Use a cork borer to bore the following holes:
   a) Bore a hole of 6 mm diameter in the rubber stopper with diameter 36 mm, which is to be fitted on the top of the plastic tube barrel, to allow the piston rod to freely move up and down through the stopper.
   b) Bore a hole of appropriate diameter in the rubber stopper with diameter 36 mm which is to be fitted at the bottom of the barrel so that the glass tube of 8 mm diameter will fit tightly in it.
   c) Bore two holes in the rubber stopper with diameter 35.5 mm diameter which serves as the piston as follows:
      i) one hole of appropriate diameter at the centre to allow press-fit insertion of the piston rod of 5 mm diameter; and

ii) one hole of appropriate diameter at a distance of about 9 mm from the central hole, to allow the tightly fit insertion of a glass tube of 8 mm diameter.

3. Cut off two pieces of rubber sheet, each with size 25 mm X 25 mm from the 1 mm thick rubber sheet to make the flap valves.

4. Fix each of these two rubber pieces, one above the hole off the centre of the piston and the other over the hole in the bottom end stopper by means of two sets of screws and nuts. Before fixing the screws and nuts, drill holes, at the two corners of one end of the rubber sheet and through the entire depth of the stopper of appropriate diameter so as to hold the screws tightly fitted. The rubber sheet flaps thus fixed over the holes act as valves, opening upwards.

5. Insert the glass tube 8 mm diameter and 16 mm long in the valve hole in the piston, taking care that the two ends of the glass are not protruding through the surfaces of the piston.

6. Insert one end of the glass tube 8 mm diameter in the central hole in the bottom cork under the rubber flap valve.

7. Insert the other end of the piston rod through the central hole of the piston. Fix the piston rod to the stopper tightly by means of jam nuts, one at the top and the other at the bottom of the stopper.

8. Insert the barrel top-end stopper through the piston rod.

9. Fix the dowel handle to the top end of the piston rod by tightening two jam nuts, one at the top and the other at the bottom of the dowel handle.

10. If the piston is not water-tight in the barrel, fix a collar of soft leather or rubber strip around the piston.

11. Apply rubber gum solution between the rubber stopper and the rubber flap where the two screws are fixed to ensure that no water will leak.

5. HOW TO USE

1. Take a bucket from which water is to be pumped by the common pump into another container.

2. Use the common pump for pumping water by holding it in one hand and operate it with the other hand.

3. Keep the glass tube immersed in water in the reservoir up to two-thirds of its projected length at the beginning of the operation, to avoid repeated adjustments of the pump, held in the supporting hand.

4. Let some students operate the pump as follows:

a) Holding the dowel handle, push the piston to its extreme bottom position inside the plastic tube barrel.

b) Pull the piston upward to its extreme top position.

c) Repeat this downward push and upward pull and push operation.several times. After three or four operations the barrel above the piston will be full of water, which will then escape through the spout fixed to one side of the barrel.

6. POSSIBLE MODIFICATIONS

Dimensions of different parts are subject to changes depending on actual requirements and availability of materials.

Source: Developed at the Bangladesh Equipment Development Bureau, Dacca, 1980.

CONDUCTOMETER

Level: Secondary and higher secondary
Subject area: Physics

1. BRIEF DESCRIPTION

The conductometer consists of rods of four different metals, fixed at the upper ends to a heat isolating material which rests over the lid of a jar, containing water. The lower ends of the metal rods lie on the same horizontal plane with equal lengths dipped into the water in the jar. The metal rods are painted with sensitive paint which will change colour with the rise of temperature.

2. OBJECTIVES

The conductometer is used to demonstrate that there are great differences in the thermal conductivity of various materials, including liquid and gases. The conductivity of solids varies widely from the very low values for asbestos fibre or brick, to the relatively high values for most of the metals. It can demonstrate that even the thermal conductivity of the metals varies from one metal to another.

The relative thermal conductivity of different substances can be demonstrated by an experiment performed with this conductometer.

3. MATERIALS NEEDED

1. Rods of four different metals: copper, aluminium, brass and tin, each with dimensions 3 mm in diameter and 150 mm long.
2. One solid, smooth-surfaced rectangular piece of wood, 100 mm long, 6 mm thick and 12 mm wide.
3. Temperature sensitive paint, yellow coloured, (or parafin wax).
4. A heat-proof glass jar or a calorimeter can 100 mm deep with an open mouth of 75 mm diameter.
5. Four machine screws, 3 mm diameter.
6. A tripod stand.
7. A gas burner or kerosene burner.
8. Water.

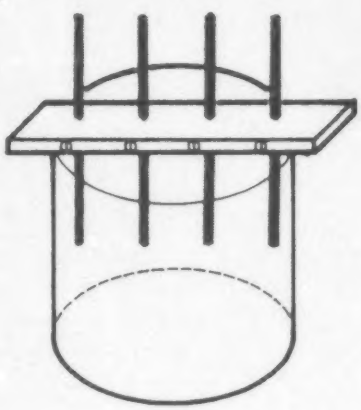


Fig.1

4. HOW TO MAKE

1. Mark a central line along the length of the rectangular block of wood with a pencil.
2. Drill two vertical holes along the marked central line, with diameter 3 mm (the diameter of the metal rods) through the rectangular wood block, at distances of 20 mm from its two ends. In the space between these two outer holes, drill along the central line two other similar holes equally spaced. The diameters of these four vertical holes should allow the metal rods to pass through them with snuggish fit.
3. Drill on one side of the wooden block four horizontal holes with diameter 2.5 mm at right angles to each of the four vertical holes.
4. Insert appropriate size screws in each of the horizontal holes.
5. Mark off 100 mm length on each of the four metal rods, by etching or with a coloured paint.

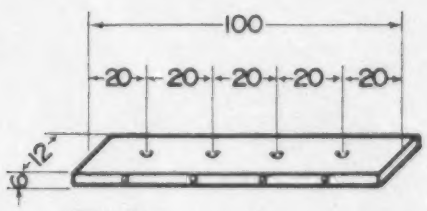


Fig.2 (a)

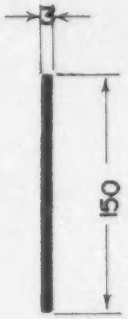


Fig. 2 (b)

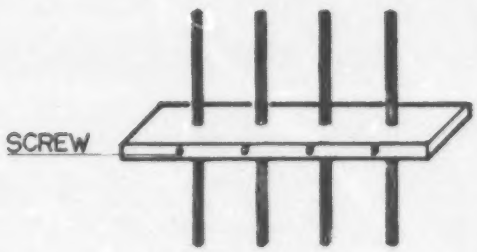


Fig. 2 (c)

6. Prepare temperature sensitive paint according to the following directions:

   a. Make separately three solutions dissolving chemicals in distilled water in the following proportions:

i) Forty grams of silver nitrate in 700 cc. of water;

ii) Sixty grams of potassium iodide in 370 cc. of water; and

iii) Seventeen grams of mercuric chloride in 280 cc. of water.

b. Add the silver nitrate solution to the potassium iodide solution. Make sure that the solutions are mixed thoroughly. Add the mercuric chloride solution in small quantities. The final precipitate will be yellow in colour. Filter off and dry. Grind this precipitate and mix with lacquer until a smooth paste is formed.

Caution: Use only good quality clear lacquer.

7. Using a brush, apply a coat of this yellow, temperature sensitive paste on the surfaces of the four metal rods, throughout the 10 cm lengths marked off and let the paste dry. Apply a second coat and let it dry. Take care that the coating of this paste is even and of approximately equal thickness on all the four metal rods.

8. Mount the temperature sensitive coated metal rods in the wooden block by inserting the non-coated ends through the vertical holes in the block.

9. After bringing the paste coated metal rods in their positions as described above, tighten the machine screws in the horizontal holes against the metal rods to hold them in an upright position.

5. HOW TO USE

1. Pour water into the glass container selected for the experiment up to 25 mm from the rim of the container. The height of the water level should be such that at least 45 mm of the metal rods are immersed in the water.

2. Place the wooden block mount with the temperature sensitive metal rods to rest on the rim of the water container, which is placed over a tripod stand. See that the lower ends of the metal rods at the two far ends do not touch the walls of the container.

3. Heat the water in the container through the bottom by means of a gas burner or a kerosene burner.

4. Direct the students to observe the following phenomena: When heating the water, the lower ends of the metal rods get heated. As the heat travels up each rod, the yellow paint gradually turns to red.

5. While the students observe how the yellow paint turns red in the metal rods, draw their attention to the fact that the redness will be different in the different metal rods.

6. Explain to the students that the distances through which the yellow paint on the metal rods will change to red and the level of redness depends on the thermal conductivity of the

metal: The greater the thermal conductivity, the greater the height through which the yellow paint will turn to red.

7. Let the students draw the conclusion that this 'conductometer' demonstrates how different substances have different thermal conductivity, as this is illustrated in Fig. 3. Fig. 3 shows a conductometer with the four different metal rods being copper, aluminium, brass and tin, all coated with the same yellow temperature sensitive paint and mounted in the order of the metals listed above. If the experiment is conducted for about five to 10 minutes, the heights through which the yellow paint has turned to red will be approximately as shown in Fig. 3 of the four metals selected for this experiment, the copper will be observed to be the best heat conductor, and the tin the poorest.

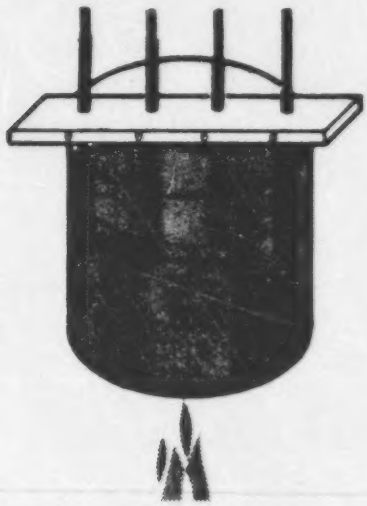


Fig. 3

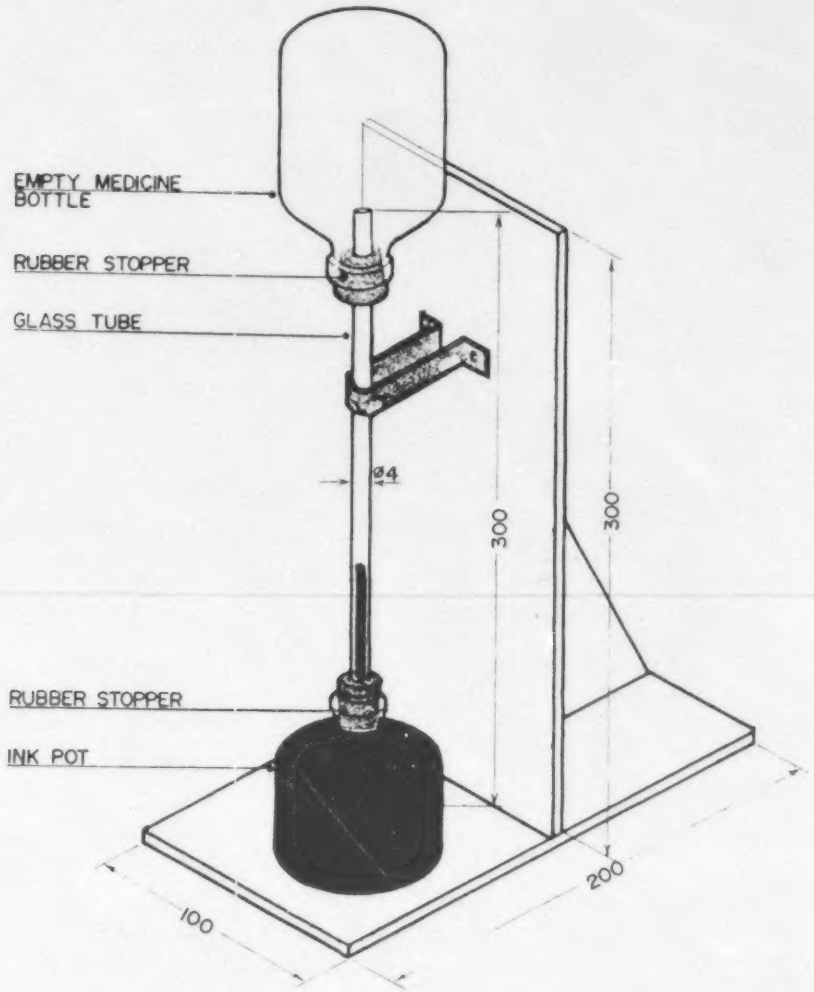
Source: Developed at the Bangladesh Educational Equipment Development Bureau, Dacca, 1980.

AIR THERMOMETER

Level: Secondary
Subject area: Physics

1. BRIEF DESCRIPTION

The air-thermometer consists of a narrow glass tube that is partially filled with coloured water or other non-volatile liquid, fixed vertically to a wooden supporting stand. The bottom end of the tube is immersed in a transparent glass inkpot, filled with the same liquid; while its top end is inserted in an empty medicine bottle. Both ends of the tube are fitted through hollow rubber or cork stoppers, as shown in the figure.



2. OBJECTIVES

To demonstrate the concept of gas thermometers based on the principle of expansion of gases when heated: When an enclosed volume of gas is heated it expands and the pressure exerted by it increases.

3. MATERIALS USED

1. A used medicine bottle.
2. Two hollow rubber or cork stoppers of appropriate size.
3. A narrow glass tube, about 4 mm external diameter and 300 mm long.
4. An empty transparent inkpot.
5. Two pieces of wood or partex (hardboard made of jute sticks) 200 mm X 100 mm and 300 mm X 100 mm.
6. Nails.
7. Coloured water or other non-volatile liquid.
8. Rubber bands.

4. HOW TO MAKE

1. Make a stand nailing the two pieces of wood.
2. Take a rubber/cork stopper of appropriate diameter and bore a hole through its centre so as press-fit the glass tube into the hole.
3. Fill the narrow glass tube with coloured water or other non-volatile liquid, keeping the lower open end closed with the finger.
4. Insert the top of the glass tube tightly through the central hole of the cork into the medicine bottle in an inverted position and keep the lower open end of the tube closed by a finger.
5. Insert the lower end of the tube, as it is partially filled with coloured liquid into the liquid in the inkpot, holding the glass tube and inverted bottle in vertical position.
6. Clamp the tube and the inverted bottle to the wooden stand.
7. Seal the tube to the rubber or cork stopper with sealing solution or wax to make the joint air-tight.

5. HOW TO USE

1. Keep the apparatus in an upright position, as shown in the figure.
2. Wrap your hands around the bottle. After a short while the column of liquid in the narrow glass tube will be pushed down slowly from its initial height.
3. Take your hands away from the bottle. The column of liquid in the narrow glass tube will now rise slowly in the tube, and will, after some time, return to the initial height.
4. Give the following explanation of the observed phenomena to the students:

   a. In the first case heat from the hands is conducted through the body of the bottle to the air inside the bottle. The

air inside the bottle, being heated, expands in volume and exerts greater pressure on the liquid, so pushing the liquid column down in the glass tube. After some time a state of equilibrium is reached, the air expands no further and the liquid column stands at a certain level in the glass tube.

b. In the second case, when the hands are taken away from the bottle, the source of heat is removed. The air outside the bottle is cooler than the air inside the bottle and some heat from the bottle and from the air inside the bottle starts flowing out to the air outside as a result of which the glass of the bottle and the air in it is cooled. As the air in the bottle and in the glass tube cools, it starts contracting in volume and the pressure exerted by it also decreases. The atmosphere pressure on the surface of the liquid in the inkpot slowly pushes the liquid up the column in the tube. It rises until the temperature of the air inside the bottle and the temperature of the air outside the bottle become equal. Then the liquid column remains stationary. Thus the students reach to the conclusion that air (and similarly any gas) expands and exerts greater pressure when heated, and contracts when cooled.

6. POSSIBLE MODIFICATIONS

1. The same experiment can be performed by heating the bottle with a candle flame or an electric bulb held against it.

2. The experiment may also be performed with the air inside the bottle and the glass tube replaced by any other gas. This will show that different kinds of gas expand to different degrees using the same amount of heat.

Source: Developed at the National Workshop on Low-cost Educational Materials, held in January 1980, Dacca, Bangladesh.

SHEET 37

THERMOSCOPE

Level: Secondary
Subject area: Physics

1. BRIEF DESCRIPTION

This apparatus consists of two identical medicine bottles containing air, connected through narrow glass tubes and plastic tube forming a U-shape and containing some non-volatile liquid, e.g. coloured water.

2. OBJECTIVES

1. To facilitate developing a concept of thermal radiation.
2. To illustrate that a black surface absorbs more and radiates more heat than a bright surface.

3. MATERIALS NEEDED

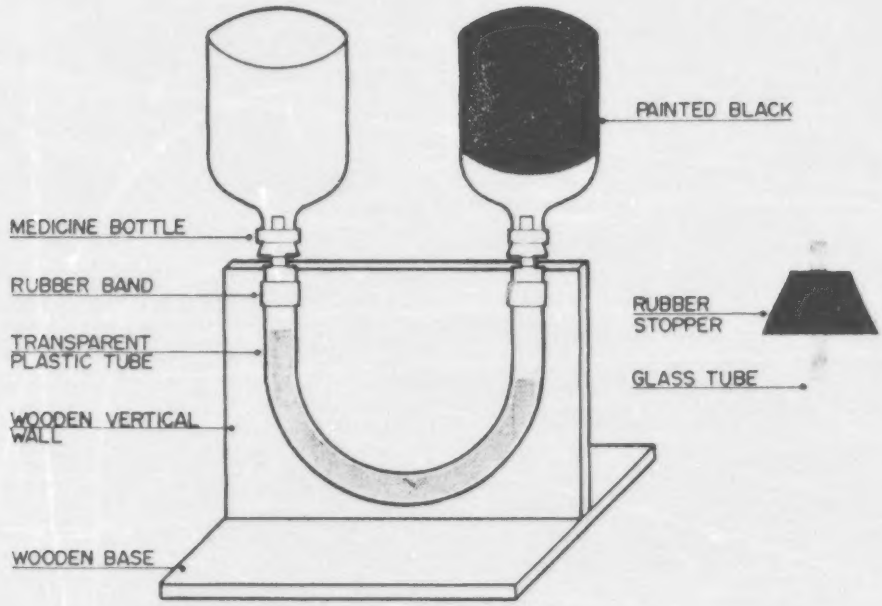
1. Two identical medicine bottles.
2. Clear plastic tube 3 mm in diameter and 250 mm long.
3. Two glass tubes, with 3 mm in diameter and 450 mm long each.
4. Two hollow rubber stoppers or corks, fitting into the mouth of the bottles.
5. A piece of wood or partex (hard board made of jute sticks).
6. Black paint.
7. Nails.
8. Rubber bands.
9. Coloured water or any non-volatile liquid.

4. HOW TO MAKE

1. Take two identical medicine bottles.
2. Insert two suitable hollow rubber stoppers or corks into the bottles and insert two narrow glass tubes through the stoppers.
3. Pour some non-volatile liquid or coloured water into the tube.
4. Connect the glass tubes with a piece of clear plastic tube.
5. Paint one of the bottles black.
6. Make a vertical stand using two pieces of wood or partex and mount the bottles along with the tube fittings in such a manner that the glass tubes connected by the plastic tube form a vertical U-shape.

5. HOW TO USE

When the two bottles are heated at the same temperature the liquid stands at the same level in the two vertical tubes but if one of the bottles is heated more than the other the level of the liquid drops



down in that tube and rises up in the other tube. By measuring the difference in the levels of the liquid in the two vertical tubes the difference in temperature of the bottles can be estimated.

1. Observe the level of the liquid in the two vertical tubes.
2. Heat the tubes with a burner situated at equal distance from the two bottles or keep the apparatus in sunshine for a while.

The blackened bottle will absorb more heat from the sun or from the burner and the level of the liquid in the tube connecting the black bottle will fall down raising the level of the liquid in the other column.

Source: National Workshop on Low-cost Educational Materials, Dacca, Bangladesh, January 1980.

SHEET 38

LARGE SMOKE BOX

Level: Secondary
Subject area: Physics

1. BRIEF DESCRIPTION

This is a teaching aid for teaching physics, representing a large smoke box for demonstrations in optics. The smoke box, shown in Fig. 1, is made of a strong cardboard box which has a tight-fitting lid removable like the lid of a shoe-box. The front long side is replaced by a sheet of glass, held in position by strong adhesive tape, to make the interior of the box visible. Two holes have been cut in the lid and a series of parallel slits cut in one end.

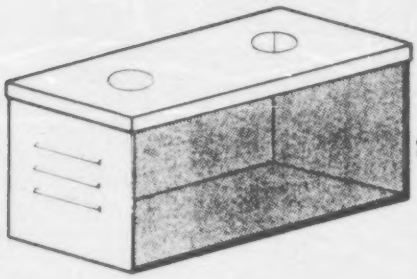


Fig.1

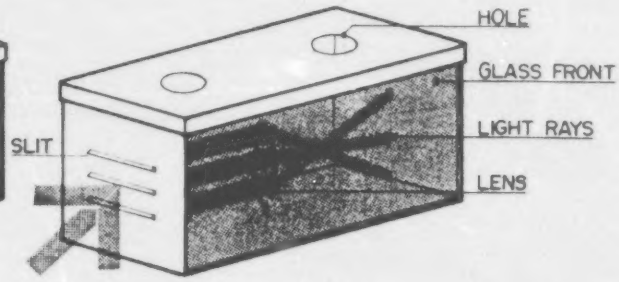


Fig. 2

2. OBJECTIVES

1. To demonstrate various optical phenomena.
2. To demonstrate convection currents in air.

3. MATERIALS USED

1. One strong cardboard box, 450 mm long, 300 mm wide and 300 mm high, with removable lid (like the lid of shoe-box).
2. A sheet of glass, 450 mm long, 300 mm wide and 2-3 mm thick.
3. Two sheets of thick paper, 50 X 75 mm each.
4. Strong adhesive tape.
5. A few rolls of touchpaper (in absence of touchpaper any smoke producing material may be used).
6. Two glass cylinders of about 65 mm diameter or two glass chimneys (used in kerosene lamps) of appropriate diameter so that they fit tightly into the 65 mm diameter holes in the lid of the cardboard box. The glass cylinders/chimneys should be about 100 - 120 mm in length.
7. Convex and concave lenses, prisms, plane mirrors, concave and convex mirrors, all mounted on suitable holders provided with at least 200 mm long arms. The sizes of lenses, prisms and

mirrors should be such that, mounted on holders, they can freely pass through the 65 mm diameter holes in the lid.

8. A thick candle, 50 - 60 mm long.

9. A fairly large plastic protractor.

4. HOW TO MAKE

1. Remove the front long side of the box, cutting it cleanly with a sharp knife or a pair of heavy duty scissors.

2. Draw a square with dimensions 50 mm X 50 mm at the middle of the one side of the cardboard box. (The square may be drawn either on the left side or on the right side).

3. At the middle of the sheet of thick paper with size 50 mm X 75 mm, cut a slit, which is 25 mm long and 1.5 mm wide, parallel to the horizontal. Cut two more slits with exactly the same dimensions, one 6 mm above the slit cut at the middle and the other 6 mm below it.

4. Mark with a pencil on the lid of the cardboard box the central line parallel to the length. Cut two holes with diameter 65 mm on the two sides of the mid-point of the central line, with their centres on the central line and situated at 100 mm distance from the mid-point of the central line each as shown in Fig. 2.

5. Fix securely the sheet of glass to the open long side of the cardboard box with strong adhesive tape. (Figs. 1 and 2).

6. To make touchpaper, soak mimeograph paper in a five to 10 per cent potassium nitrate (KNO) solution. When the paper is dry, roll it into a thin tube. When burning it produces smoke.

5. HOW TO USE

This smoke box can be used for various demonstrations in optics: a) for demonstrating a reflecting beam of light; and b) showing convection currents in air.

Demonstrations in optics - general set-up:

1. Put the lid on the cardboard box.

2. Place a parallel beam light source facing the slits. For example, a focusing flashlight or a lantern slide projector (without the objective lens) can very well be used as a parallel-beam light source.

3. Fill the cardboard box with smoke from touchpaper, burning at one end. (Any other smoke-producing source can also be used, provided there is no danger of causing fire).

4. Insert in succession different lenses and prisms, mirrors, mounted on holders with arms, and hold each lens and prism so that visible rays pass through them. The mirrors should be held in a position which is inclined towards the path of the visible rays. Effects produced by convex and concave lenses of different focal lengths, prisms and mirrors can be distinctly observed.

A. Demonstrating a reflecting beam of light

A striking demonstration of reflection of light can be made with this smoke box. For this experiment, follow the next procedures:

1. Take the lid off from the cardboard box.
2. Take a square sheet of thick paper, 8 X 8 cm, cut a slit 25 mm long X 12 mm wide at its middle and paste it over one of the 65 mm diameter hole on the lid in a way that the slit is parallel to the width of the lid.
3. Place a small plane reflecting mirror, 7 cm long X 5 cm wide X 12 mm thick, on the bottom of the smoke box, with a fairly large protractor mounted at the side of the mirror opposite to the front glass side of the box.

   This can be conveniently done by taking a piece of cardboard of wood, 75 mm long X 50 mm wide X 12 mm thick, to serve as the mount-base and attaching the protractor with strong adhesive tape at one of its long sides, facing the mount-base and placing the mirror on the mount-base face up, in contact with the protractor. Then place the whole unit, - the mount-base with the mirror and protractor, on the bottom of the smoke box with its long side parallel to the long side of the smoke box and the protractor on the side opposite to the front glass side.

   Alternatively, the protractor can be attached to the inner surface of the back side of the cardboard box, with the base line of the protractor in line with the back side of the mirror.
4. Put the lid on the top of the box so that the slit is, preferably, on the left side when observed from the front glass side.
5. Fill the box with smoke from the burning end of any other smoke-producing source.
6. Project a beam of light through the slit in the lid of the box from a focusing flashlight or from a lantern slide projector with the objective lens removed so that it strikes the mirror at an angle. The incident beam and the reflected beam of light will be visible in the smoke, and the angle of incidence and the angle of reflection can be measured with the attached large protractor placed inside the box as shown in Fig. 3.

B. Demonstrating convection air current

Convection air currents can be demonstrated very successfully with the smoke box. To do this, the following procedures should be followed:

1. Fit tightly the glass cylinders/chimneys into the two holes on the lid of the smoke box as shown in Fig. 4. If the diameters of the glass cylinders/chimneys are larger than the diameters of the holes, secure them in place by means of a cross piece of wood. If, on the other hand, the diameters of the holes are larger than the diameters of the glass cylinders/chimneys, fit them by a hollow cardboard piece, and some masking tape.
2. Remove the lid, place a candle under one hole in the lid and light the candle.

Fig.3

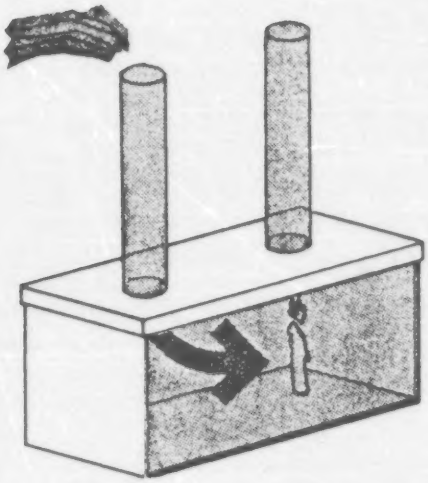


Fig.4

3. Replace the lid over the box.
4. Fit tightly the glass cylinders/chimneys onto the holes of the lid.
5. Light one end of the touchpaper and hold it above the top end mouth of the other glass cylinder/chimney (without any burning candle under it). Cigarette smoke or smoke from any other smoke-producing source can also be used in place of the smoke from touchpaper.
6. Direct the students' observation of how the smoke will descend from the burning touchpaper down the cold glass cylinder/chimney (without any burning candle under it), move across the smoke box, and lift up the warm chimney which is above the burning candle.
7. In order to show further that it is the heat (and not the burning gases from the candle flame) that produces the convection current of air inside the smoke box, replace the burning candle by a small electric heating element, like an automobile cigarette lighter. Connect the lighter to a storage battery of appropriate voltage (12 volt battery for a 12 volt lighter, and a 6 volt battery for a 6 volt lighter). Repeat the demonstration with the smoke from burning touchpaper or from any other smoke-producing source.

6. POSSIBLE MODIFICATIONS

1. To increase the visibility of white smoke, the inside of the smoke box, except the front glass plate, may be painted black.
2. All dimensions referred to in the construction of the smoke box are variable, subject to the actual requirements.

Source: Developed at the Bangladesh Educational Equipment Development Bureau, Dacca, Bangladesh, 1980.

SHEET 39

PLUG-IN CONNECTORS

Level: Lower secondary
Subject area: Physics

1. BRIEF DESCRIPTION

This simple device consists of a pair of electrical connectors for low voltage direct current experimental work in the classroom.

2. OBJECTIVES

1. To demonstrate the possible use of the connectors as a cross-over switch.
2. To demonstrate their use as an ordinary direct current switch.

3. MATERIALS NEEDED

1. Two brass bases from discarded electric torch bulbs.
2. Two brass caps from discarded 1.5 volt (D size) batteries.
3. Four pieces of P.V.C. electric wire, one meter each.
4. A rectangular piece of wooden board 80 mm X 60 mm X 30 mm.
5. Two 12 mm nails.

4. HOW TO MAKE

1. Make a hole in the centre of each of the two brass caps to admit the shank of a wire nail.
2. Fix the two caps on the wooden base as shown in Fig. 2.
3. Clean the two brass bases obtained from the electric torch bulbs by scraping off the hard material inside.
4. Solder the four pieces of P.V.C. wire to each cap and base. Coloured wire would be ideal (in four different colours).

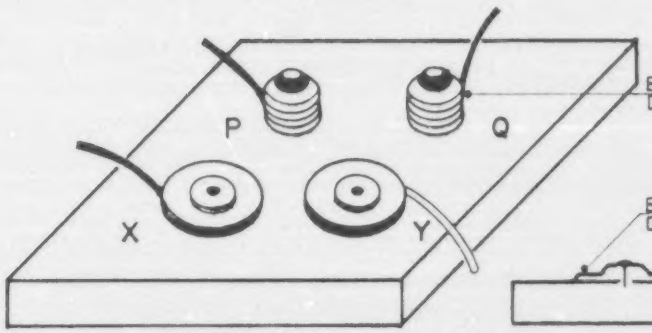


Fig. 1

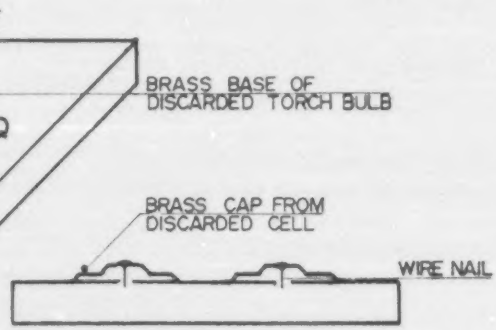


Fig.2

5. HOW TO USE

1. Connect the wire from the two caps to the terminals of the electric circuit under study. (See X and Y in Fig. 1).
2. Connect the wires from the two brass bases to the terminals of the voltage supply as shown in points P and Q in Fig. 1. When the bases are plugged onto the caps, electric current passes through the circuit. When one base is removed, no current flows (this illustrates the ordinary "switch action").

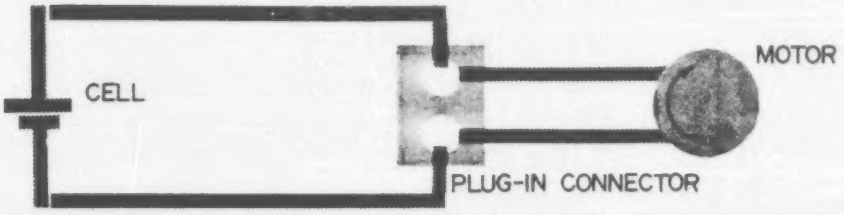


Fig. 3

3. When the two bases are interchanged and plugged onto the caps, the direction of current in the circuit is changed (this illustrates the "cross-over action") which is explained below.
4. To demonstrate "cross-over action" and "switch action", connect a torch cell, a plug-in connector and an electromotor in series, as shown in the circuit diagram (Fig. 3).
   a. When one plug is removed, the motor stops. This demonstrates the ordinary switch action.
   b. When the two plugs are interchanged the motor revolves in the opposite direction demonstrating "cross-over action".

Source: Report of the National Workshop on Educational Technology, Colombo, Sri Lanka, 1980.

MINI STORAGE ELECTRIC CELL

Level; Secondary
Subject area: Science

1. BRIEF DESCRIPTION

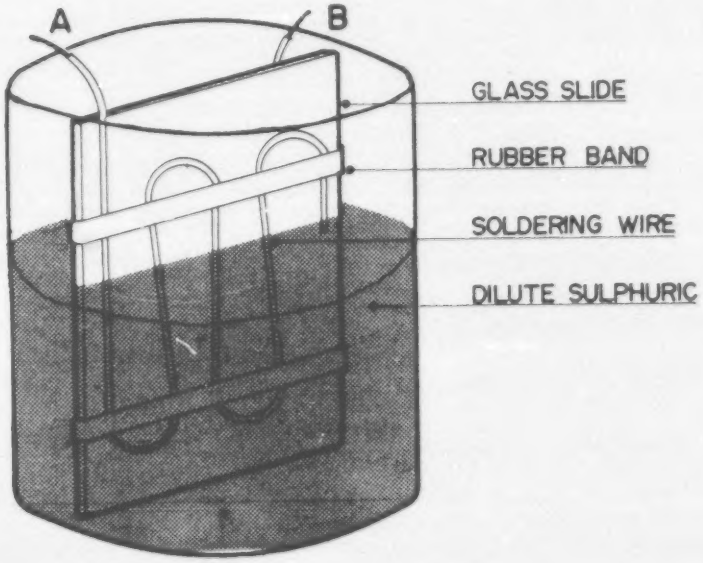
This is a model of a secondary electric cell.

2. OBJECTIVES

1. To demonstrate the action of a secondary electric cell.
2. To show colour changes occuring at the anode and the cathode during charging and discharging of the cell.
3. To illustrate transformation of energy.

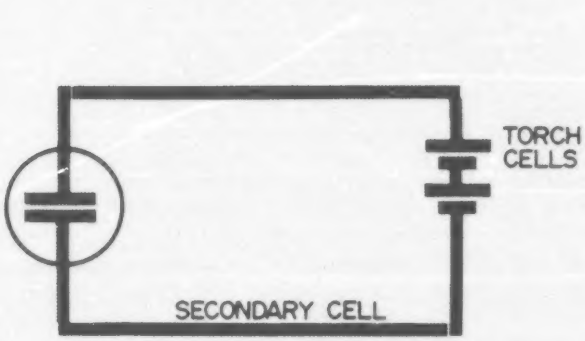
3. MATERIALS NEEDED

1. A transparent plastic or glass vessel with volume about 100 ml.
2. One microscope glass slide of standard size.
3. Two pieces of lead soldering wire of diameter 3 mm each, about 250 mm long.
4. Two rubber bands.
5. Insulated connecting wire (P.V.C. wire).
6. Sufficient diluted sulphuric acid to immerse the glass slide.
7. Two torch cells.
8. One 2.8 volt torch bulb of 100 ma or less.

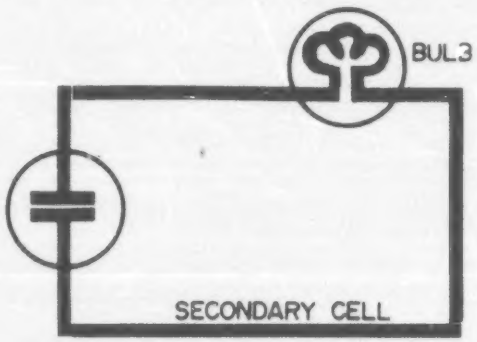


4. HOW TO MAKE

1. Bend each piece of soldering wire as shown in Fig. 1.
2. Fix these two bent pieces of soldering wire on either side of the microscopic slide with the rubber bands as shown in Fig. 1.
3. Place this in the transparent vessel which is half filled with diluted sulphuric acid.



CIRCUIT DIAGRAM 1.



CIRCUIT DIAGRAM 2.

5. HOW TO USE

1. Connect the ends A and B of the wire to a bulb 2.8 volt and demonstrate that the bulb is not alight (Circuit diagram 2).
2. Connect the ends A and B of the wire to two torch cells in series and wait about three minutes. Now the storage cell is charged and ready for demonstration (Circuit diagram 1).
3. Connect a small bulb of 2.8 volt with this cell and draw the students' attention to the fact that the bulb is alight (Circuit diagram 2).
4. Activate students' discussion to explain this phenomena through the discovery method and let some students repeat the experiment, if necessary, warning them of the danger when dealing with sulphuric acid.

6. POSSIBLE MODIFICATION

In place of the electric bulb a tiny electromotor of less than 3 volt can be connected to the cell.

Source: Report of the National Workshop of Educational Technology, Colombo, Sri Lanka, 1980.

SIMPLE ELECTROSCOPE

Level: Secondary
Subject area: Physics

1. BRIEF DESCRIPTION

The simple electroscope consists of two light sola pieces (inner pulp of jute stick) suspended by two separate silk threads from a common support. The support is a thick metal wire bent in such a form that it stands upright by itself. The silk thread is tied at the end of the upper horizontal part of the support as shown in Fig. 1.

2. OBJECTIVES

Detection of small electric charges and determining the nature of charge.

3. MATERIALS NEEDED

1. Galvanized iron wire with diameter 7 mm, 550 mm long.
2. Two sola pieces (inner pulp of jute stick), 12 mm in diameter, 16 mm long, or similar size of polystyrene material.
3. One-ply silk thread, 250 mm long.

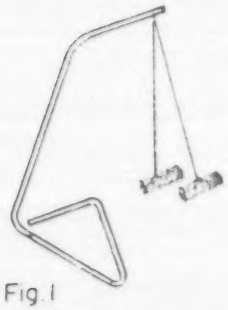


Fig.1

Fig.2

Fig.3

Fig.4

Fig.5

4. HOW TO MAKE

1. Bend the galvanized iron wire in the form shown in Fig. 2, so that it rests firmly on its flat horizontal part without any tilt. This forms the stand of the simple electroscope.
2. Split each of the two sola pieces at one end - at the middle, along the length, up to half its length (Fig. 3).
3. Make knots at the two ends of the silk thread. Push the two ends of the silk thread through the split ends of the two sola pieces up to the middle of their lengths. Pull the thread gently at the ends protruding out of the sola pieces against the knotted ends till the sola pieces rest on the knotted ends (Fig. 4).
4. Suspend the silk thread, with the sola pieces at its two ends, at the middle of its length, from the upper horizontal part of the galvanized wire stand (Fig. 5).

5. HOW TO USE

This electroscope may be used for two kinds of experiments: a) Detection of small electric charges; and b) Determining the nature of charge.

A. Detection of charge

1. Since the material, sola, is a conductor of electricity, in order to ensure that no electric charge remains on the sola pieces, touch the two sola pieces with fingers. The sola pieces will rest hanging vertically and close to each other as shown in Fig. 6.

2. Bring the body under examination for detection of electric charge close to the uncharged sola pieces.

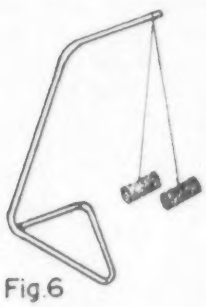


Fig.6

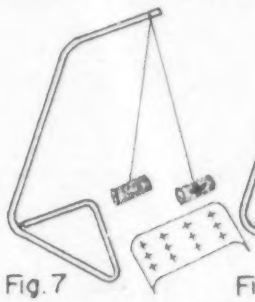


Fig.7

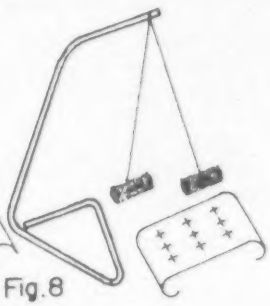


Fig.8

3. Direct the students' attention to each one of the following phenomena that will take place:

   a. Either the sola pieces will remain stationary; or

   b. The sola pieces will first be attracted to the body under examination as shown in Fig. 7 and then, after touching the body, the sola pieces will be repelled away from the body and from each other, as shown in Fig. 8.

4. Explain these phenomena to the students, bringing them to the conclusions that:

   a. In the case of the first phenomenon, the body under examination is charged (guide the students' thinking to derive at this conclusion through discussion).

   b. In the case of the second pheonomenon, the body under examination is charged. (Through discussion the students should reach the conclusion that the initial attraction is due to the electrical attraction between the charged body and the sola pieces acting as uncharged bodies. When they come into contact, a portion of the charges of the body is transferred to the sola pieces). Then, a repulsion between identical charges on the charged body and the charged sola pieces occurs, as well as between identical charges on the charged sola pieces.

B. Experiment for determining the nature of charge

In this experiment the body under examination should be charged. The nature of the charge can be determined in the following way:

1. Touch the sola pieces with fingers to ensure that no electric charge remains on the sola pieces.
2. Charge the sola pieces with, for example, positive electricity, The sola pieces will first move away from each other due to repulsion between identical charges on them and then will come to a rest but separated from each other as shown in Fig. 9.
3. Bring the charged body under examination near the positively charged sola pieces.
4. Guide the students' observation of either of the two phenomena that will occur:
   a. The two sola pieces will be attracted towards the charged body under examination as shown in Fig. 10; or
   b. The two sola pieces will be repelled from their stationary positions and away from the charged body under examination as shown in Fig. 11.

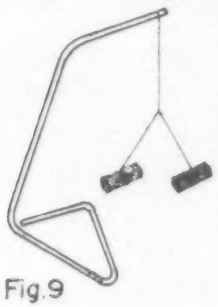


Fig.9

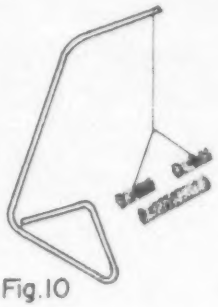


Fig.10

Fig.11

5. Through discussion lead the students to reach the following conclusions and explanation of the phenomena observed:
   a. In the case of the first phenomenon, the charged body under examination is negatively charged. The students observe that the positively charged sola pieces will be attracted towards the charged body under examination only if it is negatively charged, since attraction occurs between two differently charged bodies.
   b. In the case of the second phenomenon, the charged body under examination is positively charged. The students now observe that the positively charged sola pieces will be repelled from the charged body only if it is charged positively, since repulsion occurs between two identically charged bodies.

Remark: In moving the body under examination, charged or uncharged, it should not be touched with fingers or any tool which is a conductor of electricity.

Source: Developed at the Bangladesh Educational Equipment Development Bureau, Dacca, Bangladesh, 1980.

ELECTROSCOPE

Level: Secondary
Subject area: Physics

1. BRIEF DESCRIPTION

This is a sensitive type of electroscope used for the detection of small electric charges, and for examination and identification of the nature of charges.

The electroscope consists of an inverted transparent plastic drinking tumbler commonly available in the market (see Fig. 1). The other components are a bent, narrow rectangular brass strip - fixed to the bottom surface of the tumbler and a paper drinking straw suspended at its middle in a slit cut in the middle of the rectangular brass strip and held in position by a pin. The straw can freely move around the pin without touching the sides of the plastic tumbler. A brass disc is soldered to a hexagonal nut which is fixed to the free end of the screw securing the rectangular strip inside the tumbler.

Fig.1

2. OBJECTIVES

1. To detect small electric charges.
2. To examine the nature of electric charges.

3. MATERIALS NEEDED

1. Transparent plastic drinking tumbler normal size (available in the market).
2. Brass strip, 140 mm long, 12 mm wide, 1 mm thick.
3. Brass disc with diameter 45 mm, and 1 mm thick.
4. Paper drinking straw, 65 mm long.
5. Brass screw, round-headed, 5 mm diameter thread, 25 mm long.
6. Brass nut, rectangular, 5 mm diameter thread, normal size.
7. Brass nut, hexagonal, 5 mm diameter thread, normal size.
8. Stapling pin.
9. P.V.C. sheet , 150 mm long, 50 mm wide.
10. A piece of dry paper or dry cloth.

4. HOW TO MAKE

1. Drill a hole at the centre of the base of the plastic drinking tumbler with diameter to fit a round-headed 5 mm screw.
2. Cut an oblong slit about 12 mm X 6 mm at the middle of the brass strip as shown in Fig. 2.
3. Drill a hole at one end of the brass strip with the diameter large enough to fit the screw passing through the bottom of the tumbler.
4. Bend the brass strip into the shape shown in Fig. 2.
5. Suspend the 65 mm long drinking straw inside the slit in the rectangular brass strip as shown in Fig. 2 by means of a stapling pin passing through the middle of the drinking straw and bend its two ends around the edges of the brass strip.

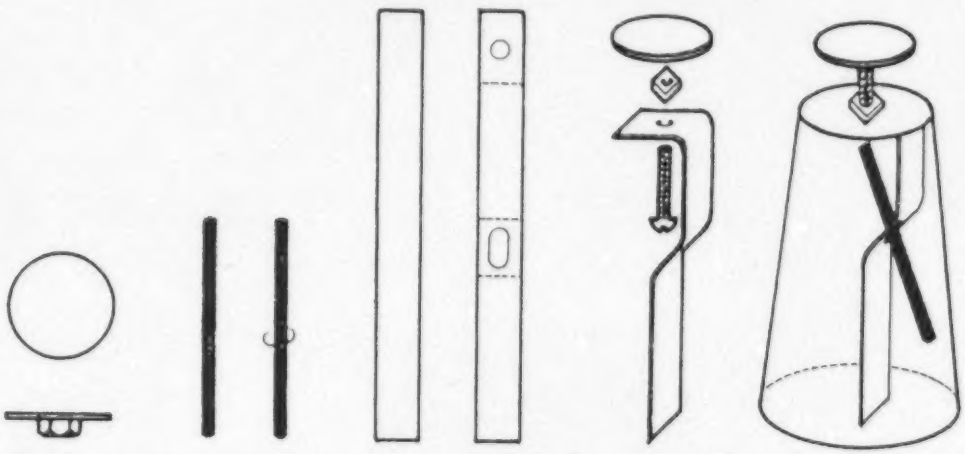


Fig. 2

6. Solder the round brass disc to one of the flat surfaces of the hexagonal nut.
7. Insert the round-headed screw first through the hole at the short bent end of the brass strip, with the round-head of the screw at the bottom of the brass strip, and then through the central hole in the bottom of the plastic drinking tumbler while the tumbler is held in inverted position.
8. Screw a 5 mm diameter nut on the outer side of the base of the plastic tumbler. The screw and the nut are tightened to fix the hanging brass strip, with the drinking straw suspended at its middle as shown in Fig. 2.
9. Fix the brass disc soldered to the hexagonal nut on the free top end of the screw and tighten the nut (see Fig. 2). The brass disc rests horizontally at the top end of the screw.

Note: The size of the plastic drinking tumbler should be such as to provide sufficient space for free movement of the straw without touching the sides of the tumbler.

5. HOW TO USE

The electroscope can be used for:

A. Detection of small electric charges; and

B. Examination of the nature of charges.

A. Detection of small electric charges

1. Place the electroscope on the dry flat surface of a table.
2. Touch the brass disc of the electroscope with fingers to ensure that the electroscope becomes free of electrical charge. The drinking straw should rest in a stationary position with its two ends near to the vertical brass strip.
3. Bring the body under examination near the brass disc of the electroscope. One of the following two phenomena will occur:
   a. The drinking straw will not move from its initial position.
   b. The drinking straw will diverge from its initial position with the two ends moving away from the vertical brass strip.
4. Guide the students to draw the following conclusions:
   a. In the case 3.a., the body under examination is uncharged.
   b. In the case 3.b., the body under examination is charged.
5. Provide the following explanation of these phenomena to the class:
   a. In the case 3.a, the electroscope is not charged and the drinking straw is also uncharged. Since the straw does not move from its resting position, it clearly shows that no separation of electric charges takes place on the brass disc, the brass strip and the straw through electrostatic induction.
   b. In the case 3.b., since the straw diverges from its initial stationary position, it clearly shows that separation of electric charges has taken place in the brass disc, the brass strip and the drinking straw through the process of electrostatic induction, following which the straw has diverged from its initial position of rest. Separation of electric charges in an uncharged body during the process of electrostatic induction can take place only when a charged body is brought near to it. In such case, since the electroscope is uncharged the examined body must be an electrically charged one.

B. Examination of the nature of charges

To examine the nature of the electric charges on the body undergoing examination, the electroscope has to be first charged, either with a positive or negative electric charge. The electroscope can be charged with electric charges either through the method of electrification by conduction or by induction.

1. Charging of the electroscope by conduction (through direct contact):

   a. Let a student touch the brass disc of the electroscope with his fingers to ensure that no electric charge remains on the electroscope and the electroscope becomes completely discharged.

   b. Place the P.V.C. sheet on the dry surface of the table. Rub the surface of the P.V.C. sheet several times with a lump of dry cloth or with a lump of dry paper. The P.V.C. sheet is, thus, charged negatively. Holding one end of the P.V.C. sheet, bring it near to the brass disc of the uncharged electroscope. The straw in the electroscope will gradually diverge from its position while in an uncharged condition as the charged P.V.C. sheet is brought nearer to the disc. Finally, touch the disc with the charged P.V.C. sheet. At this stage, the electroscope is charged with negative electric charges by conduction, and the straw is diverged to a maximum extent from its initial stationary position.

   c. Take away the negatively charged P.V.C. sheet from the disc and away from the electroscope. The divergence of the straw remains unchanged.

2. Charging by induction. The method of induction is convenient and effective for charging an electroscope. To charge by induction, follow the next steps:

   a. Put the P.V.C. sheet on the top of a dry table. Rub the P.V.C. surface well with a lump of dry cloth or paper. The P.V.C. sheet becomes negatively charged.

   b. Hold the negatively charged P.V.C. sheet near the disc of the uncharged electroscope. Due to electrostatic induction, the disc becomes charged positively, and the lower brass strip and the straw-negatively. The identical charge in the lower brass strip and the straw causes the divergence of the straw.

   c. Without moving the negatively charged P.V.C. sheet which is closed to the disc of the electroscope, momentarily touch the disc with fingers. The free negative charges on the lower brass strip and the straw will escape to the earth (flowing through the finger and the body). As a result the straw will collapse and will come back to its previous position when the electroscope was not charged. But the

positive charges on the disc will remain due to the attraction between the positive charges on the disc and the negative charges on the P.V.C. sheet held near the disc.

d. Take the negatively charged P.V.C. sheet away from the disc. Due to repulsion between them, only the positive charges on the disc, will distribute themselves on the disc, the brass strip and the straw. Hence, the straw will again diverge, this time with positive charges on it. The electroscope is, thus, charged with positive electric charges by induction.

3. Identification of charges. After charging the electroscope by one of the above methods, guide the students to identify the nature of the electric charge. The identification of the nature of charge on a charged body can be made by a charged electroscope, in both the cases, when the electroscope is charged negatively, and when the electroscope is charged positively, regardless of the method of charging employed: either through the method of conduction or by the method of induction.

   a. When the electroscope is charged negatively:

      i) Bring the charged body under examination near the negatively charged disc of the electroscope. Guide the students' observations on either of the following two phenomena that will occur:

         1) The divergence of the negatively charged straw (since the electroscope is charged negatively) increases, or,

         2) The divergence of the negatively charged straw decreases.

      ii) Guide the students to draw the following conclusions:

         1) If the divergence of the negatively charged straw increases (Case 1)) the charged body under examination is negatively charged.

         2) If the divergence of the negatively charged straw decreases (Case 2)), the charged body is positively charged.

      iii) Through the question-answer method, guide the students to find an explanation for the phenomena observed:

         1) The case when the disc, the brass strip and the straw of the electroscope are negatively charged. (Since it is observed that the divergence of the negatively charged straw increases, it can only mean that there has been an accumulation of more negative charges on the straw and the brass strip than prior to bringing the charged body under examination near to the disc of the electroscope). This can only occur, in this case, if the charged body under examination is positively charged.

b. When the electroscope is positively charged: Bring the charged disc of the electroscope. In this case also, either of the following two phenomena will occur:

i) The divergence of the positively charged straw increases, or

ii) The divergence of the positively charged straw decreases.

Let the students draw the following conclusions:

i) If the divergence of the positively charged straw increases, (Case i)), the charged body under examination is positively charged.

ii) If the divergence of the positively charged straw decreases, (Case ii)), the charged body under examination is negatively charged.

Guide the students to make the following explanations of the phenomena observed:

Case i):

Since it is observed that the divergence of the positively charged straw increases, it means that there has been an accumulation of more positive charges on the straw and the brass strip than prior to bringing the charged body near to the disc of the electroscope. This can only occur if the charged body is positively charged.

Case ii):

Since it is observed that the divergence of the positively charged straw decreases, it means that the straw and the brass strip have fewer positive charges than previously, which can only occur if the charged body under examination is negatively charged.

Source: Developed at the Bangladesh Equipment Development Bureau, 1980.

THERMOPILE

Level: Secondary
Subject area: Physics

1. BRIEF DESCRIPTION

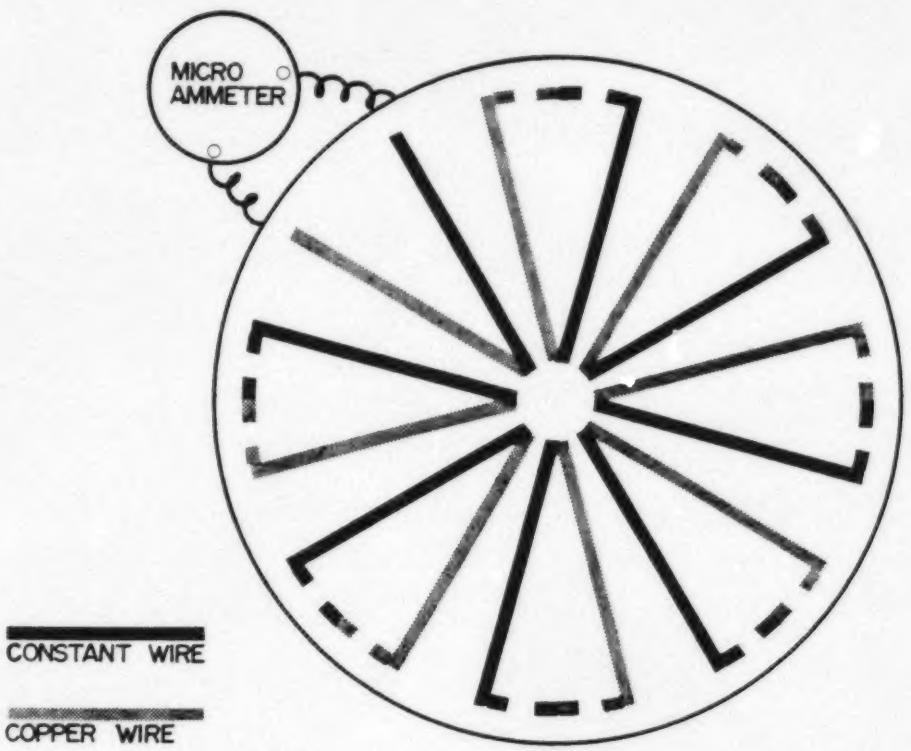
The thermopile is a device consisting of a series of thermocouples, used for measuring minor changes in temperature, or for generating thermoelectric current.

2. OBJECTIVES

To demonstrate that solar energy can be converted into electricity.

3. MATERIALS NEEDED

1. Constant wire, e.g. SWG 30.
2. Copper wire, e.g. SWG 30.
3. Micro ammeter.
4. Optical lens.
5. A circular piece of plywood.



4. HOW TO MAKE

1. Make a plywood disc with diameter 100 mm.
2. Thread the wires on to the disc as shown in the diagram to make alternate junctions of the wires so as to converge near to the centre of the disc and to diverge along its periphery.
3. The joints can be fixed by hammering them.

5. HOW TO USE

1. Connect the ends of the wires to a micro-ammeter.
2. Focus the sun's rays on to the joints at the centre by means of an optical lens, held at a proper distance.
3. Explain to the students the phenomenon observed, which proves that solar energy can be converted into electricity.

6. POSSIBLE MODIFICATIONS

1. Higher electromagnetic force can be obtained by increasing the number of joints.
2. More current can be obtained by joining many of these sets in series and connecting the series in parallel.
3. This can be achieved also by painting the central portion black and covering this area with a sheet of glass. Care must be taken to prevent conduction of heat from the joints at the centre to those at the periphery.

Source: Developed during the second series APEID National Workshop on Educational Technology at the Curriculum Development Centre, Colombo, Sri Lanka, October 1980.

MAGNETIC FIELD ILLUSTRATING KIT

Level: Primary and secondary
Subject area: Science

1. BRIEF DESCRIPTION

The educational kit consists of fine ferrous particles sealed between two sheets of acetate and one or more magnets to be used with an overhead projector.

2. OBJECTIVES

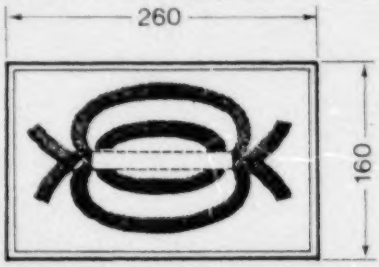
1. To help learners understand the basic concepts of a magnetic field.
2. To illustrate the properties of magnets.
3. To illustrate magnetic fields created by magnets.

3. MATERIALS NEEDED

1. Two sheets of clear acetate (size 160 X 260 mm each).
2. Masking tape.
3. Third grade ferrous particles (approximately 30 grams).

4. HOW TO MAKE

1. Place two sheets of acetate together and seal three of their sides with masking tape so as to form an envelope.
2. Pour the ferrous particles into the opening of the acetate envelope.
3. Seal the remaining side.



5. HOW TO USE

1. Shake the acetate envelope so that the particles are evenly spread.
2. Place the acetate envelope on an overhead projector to show the initial position of the particles to the students.
3. Place the magnet(s) over the acetate envelope.
4. Let the students observe the various shapes formed by the magnetic field.

6. POSSIBLE MODIFICATIONS

When an overhead projector is not available, place a white sheet of paper under the acetate envelope and proceed as described above.

Source: Korean Educational Development Institute, Educational Resources Handbook for Primary Education, Seoul, Republic of Korea: KEDI, 1980.

SIMPLE MICROSCOPE

Level: Secondary
Subject area: Science

1. BRIEF DESCRIPTION

This is a simple microscope in which a glass bead that acts as the lens of the microscope is cemented into a square piece of plywood. A short piece of brass angle profile is mounted below the lens, in line with the lens. A brass nut is soldered into the extending angle arm. A long brass screw with its tip filed to a fine sharp point, is screwed in the brass nut with its pointed end projecting upwards. The screw can be raised or lowered by screwing it through the brass nut.

2. OBJECTIVES

To produce magnified image of very tiny objects and make them distinctly visible. To be used for exploring crystals, living micro-organisms, microscopic objects, chemicals, textile and various other fibres.

3. MATERIALS NEEDED

1. A tiny glass bead with spherical shape.
2. Two pieces of square-shaped plywood, 12 mm thick, 10 X 10 cm
3. A short piece of brass angle profile 50 X 50 mm.
4. A brass nut with 6 mm thread.
5. A long brass screw with 6 mm thread (the same as the thread of the nut).

Its length is determined by the distance from the brass angle profile to the level of the glass bead.

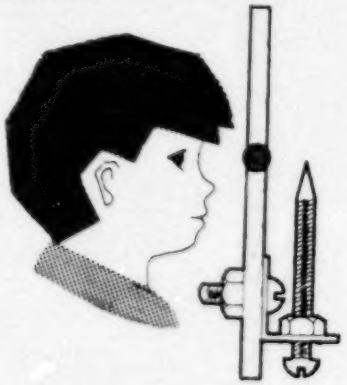


Fig. 1

4. HOW TO MAKE

1. If a glass bead is not readily available, it can be made in one of the following ways:
   a. Small glass beads can be obtained by breaking off the round tip portion of the small flash-light used bulbs; or

b. Make glass beads by melting a thin glass rod in a Bunsen burner flame or a high-temperature stove flame and cutting the globules formed at the melted portion of the glass rod.

2. Drill in the centre of the 12 mm thick square piece of the horizontal piece of plywood a hole with appropriate diameter to host the glass bead.

3. Using the universal glue "Uhu" or similar, cement the glass bead into the opening drilled in the square piece of plywood. This will be the lens of the microscope.

4. Cut off a short (50 mm) piece of brass angle and drill through its two arms holes with appropriate diameters to allow the two screws to pass through (shown in Fig. 2).

5. Mount the short piece of brass angle profile onto the plywood piece about 25 mm below the lens, in line with the lens.

6. Carefully solder the brass nut onto the extending angle arm above the hole in it.

7. File the tip of the long brass screw to a fine point.

8. Screw the long brass fine-pointed screw through the soldered brass nut.

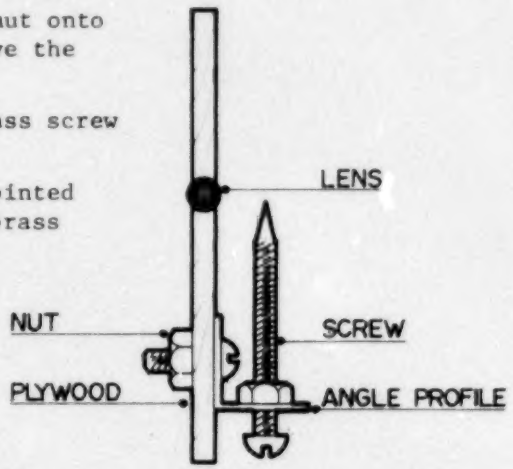


Fig.2

5. HOW TO USE

1. The small round glass bead acts as the lens of this simple microscope.

2. Dip the threaded brass screw fine-point tip into some crystals or into a culture of living organisms.

3. Hold the microscope, place the glass-bead lens near the eye, align the lens and the object by turning the screw to bring its sharp tip nearer in line with the lens and focus the image by moving the microscope lens towards your eye or away from your eye.

6. IMPORTANT NOTE

In using the simple microscope, a source of light should be used to sufficiently illuminate the materials which are to be observed.

Source: Developed at the Bangladesh Educational Equipment Development Bureau, Dacca, Bangladesh, 1980.

TONGUE DEPRESSOR MICROSCOPE

Level: Lower secondary
Subject area: Physics, chemistry and biology

1. BRIEF DESCRIPTION

This is a simplified version of the Van Leeuwenhock microscope using a screw thread for focusing the microscope slides. The ends of two identical tongue depressors are joined together with masking tape or adhesive tape forming a hinge and are foled together. A small glass bead lens is cemented into a hole drilled in one of the tongue depressors, at about 40 mm distance from its free top end (Fig. 1). The microscope slide under examination can be held in position on the inner side of the tongue depressor B against the hole drilled in it, 40 mm below its top end.

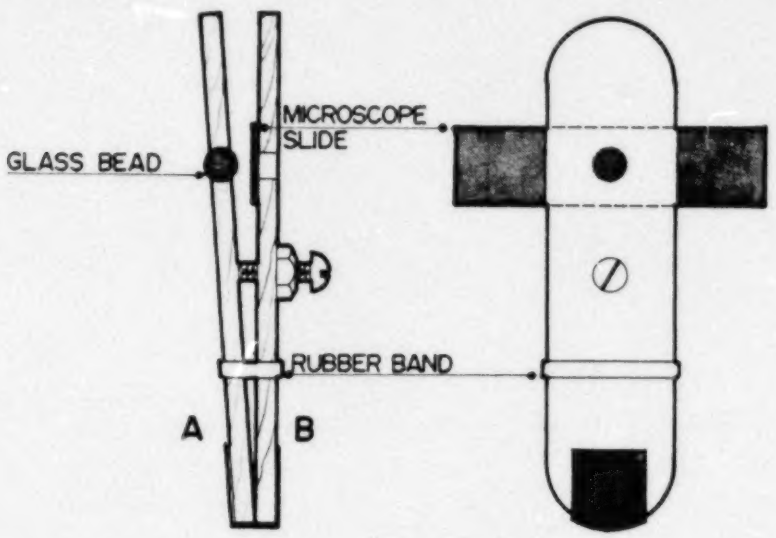


Fig. 1 Fig. 2

2. OBJECTIVES

The tongue depressor microscope is designed to fulfil the following objectives:

1. To produce magnified images of very small and microscopic objects so as to make them distinctly visible.
2. To be used for exploring and examining crystals, chemicals, living micro-organisms and various microscopic objects.

3. MATERIALS NEEDED

1. Two tongue depressors from wood or plastic (commonly available in the market).
2. A small glass bead lens, 5 mm or 6 mm in diameter.
3. A brass nut.
4. A long brass screw with thread fitting the brass nut.

5. Strong rubber bands.

6. Masking tape or adhesive tape.

7. Cement glue.

4. HOW TO MAKE

1. If tongue depressors are not available they can be made easily. For making a tongue depressor follow the steps:

   a. Take a plastic strip which is 1.5 mm thick, 100 mm long, and 18 mm wide. Cut it into two pieces, or;

   b. Take a strip of wood 1.5 mm thick, 100 mm long and 20 mm wide. Cut it into two pieces. Make the two surfaces and the sides smooth using sand paper.

2. Small glass beads can be obtained by either:

   a. Cutting the round tip portion of a small used flash light bulb; or by

   b. Melting a thin glass rod in a Bunsen burner flame or a strong stove burner flame and cutting off the small globule formed at the molten end of the glass rod.

3. Drill a tiny hole (aperture opening) in one of the tongue depressors about 40 mm from the top end so that it can accommodate the tiny glass bead lens with diameter 1.5 mm or 3 mm. The smaller the diameter of the lens the better its magnification.

4. Fit the glass bead lens tightly the tiny hole made in this tongue depressor. If necessary use a thin film of glue around the inner surface of the aperture opening.

5. Aligned with the tiny hole i.e. about 40 mm from the top end, drill an aperture opening with diameter 8 mm or 6 mm on the second tongue depressor to admit light.

6. Drill a second hole about 50 mm below the first hole on the second tongue depressor, with diameter slightly more than 3 mm.

7. Above this hole, attach a brass nut using good quality glue. Allow about one day for the glue to dry.

8. Screw the long brass screw through the brass nut.

9. Join the lower ends of the two tongue depressors with masking tape or adhesive tape to form a hinge and fold them together as shown in Fig. 2.

10. Fasten a fairly strong rubber band around the centres of the two tongue depressors.

5. HOW TO USE

This microscope can be conveniently used when held. However, it can be used by fixing it to a long supporting stand by a jaw clamp (with its arm fixed to the supporting stand by a clamp), firmly gripping the tongue depressor with the glass bead lens and holding the microscope in an upright position.

To use the microscope follow these procedures:

1. Using a rubber band, attach the microscope slide to be examined above the light-admitting aperture opening and preferably, to the inner surface of the tongue depressor "B" (the tongue depressor without the glass-bead lens).
2. Hold the microscope by hand in an upright position, bring the glass bead lens in level with the eye and screw in the brass screw till its end touches the tongue depressor fitted with the glass bead lens.
3. Illuminate the light-admitting aperture opening on the tongue depressor "B" with a strong source of light.
4. Align the observer's eye against the glass bead lens and focus by turning the brass screw in or out, thereby increasing or decreasing the distance between the lens and the object on the microscope slide.

6. POSSIBLE MODIFICATIONS

An iron nut and screw can very well be used in place of brass nut and screw. All dimensions are subject to change in the light of actual requirements.

Source: Developed at the Bangladesh Educational Equipment Development Bureau, Dacca, Bangladesh, 1981.

SIMPLE OSMOSCOPE

Level: Secondary
Subject area: Science

1. BRIEF DESCRIPTION

This apparatus is also called the fish-bladder osmoscope. The apparatus demonstrates the phenomenon of osmosis in physics.

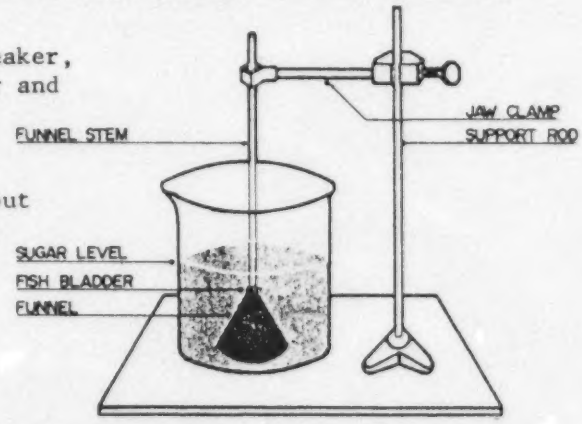
It consists of a long transparent plastic funnel and a narrow stem. The open mouth of the funnel is covered with a clean fresh fish-bladder, tied to the neck of the funnel so tightly as to make it water-tight. The funnel, with its mouth covered by the fish-bladder, is hung in an inverted position partly filled with concentrated sugar solution. The fish-bladder covered mouth is immersed upto its neck in clean water in a large transparent plastic or glass beaker placed above a tripod stand.

2. OBJECTIVES

To demonstrate the phenomenon of osmosis in two liquids with different concentration.

3. MATERIALS NEEDED

1. A transparent plastic funnel, with 50 - 70 mm diameter mouth and narrow stem about 300 mm long.
2. A piece of fresh clean fish-bladder, of such size that after covering the mouth of the funnel its edges can be tied around the neck of the funnel.
3. A transparent plastic beaker, about 100 mm in diameter and 130 - 150 mm long.
4. A tripod stand.
5. A support stand with about 900 mm long support rod.
6. Sugar.
7. A long piece of cotton thread.



4. HOW TO MAKE

1. Clean the transparent plastic funnel. If a funnel with 300 mm long stem cannot to obtained, take a transparent plastic tube which fits the stem of the funnel. Insert the stem of the funnel inside the plastic tube to a length of about 15 - 25 mm and tie the two together tightly. Put some transparent plastic gum around the junction and let it dry to make it water-tight.
2. Clean the fish-bladder well.
3. Cut the fish-bladder sround the edge with scissors to obtain a size adequate to cover the mouth of the funnel and to allow its edges to be tied around the neck of the funnel.

4. Cover the mouth of the funnel with the fish-bladder and tie the edges tightly around the neck of the funnel to make it water-tight. If necessary apply some waterproof sealing glue or paste.

5. Hang the funnel in inverted position with its mouth covered by the fish-bladder held at the end of its stem by a jaw clamp with its arm clamped to the rod of the support stand.

5. HOW TO USE

1. Prepare concentrated sugar solution. Pour this concentrated sugar solution in the inverted funnel through the open end of the stem and fill it up to 30 - 50 mm above the neck of the funnel.

2. Place the large transparent beaker on the tripod stand and fill it with clean water up to about two-thirds of its volume.

3. Bring the funnel, hung in the inverted position from the support stand and filled up with concentrated sugar solution, near the beaker placed on the tripod stand filled with water.

4. Adjusting the position of the jaw clamp on the support rod, immerse the funnel into the water in the beaker upto its neck.

5. Guide the students to make the following observation: After the funnel, filled with the concentrated sugar solution, is immersed in the water in the beaker, the level of the concentrated sugar solution is observed to rise in the stem of the funnel, demonstrating that the water with lower concentration than the sugar solution has permeated through the fish-bladder membrane to the higher concentration sugar solution in the funnel. This proves that a liquid with lower density, due to the phenomenon of osmosis, permeates through a membrane into a liquid with higher density. When the experiment is reversed by filling the funnel with water and the beaker with concentrated sugar solution, it is observed that the level of water in the stem goes down, proving, again the phenomenon of osmosis.

6. POSSIBLE MODIFICATION

1. A glass funnel and beaker can be used in place of transparent plastic funnel and beaker.

2. All dimensions are subject to change depending on the actual requirements and availability of materials.

Source: Developed at the Bangladesh Educational Equipment Development Bureau, Dacca, Bangladesh, 1980.

SIMPLE TRANSPIRATION APPARATUS

Level: Secondary
Subject area: Science

1. BRIEF DESCRIPTION

This apparatus demonstrates how the transpiration in plants produces suction force.

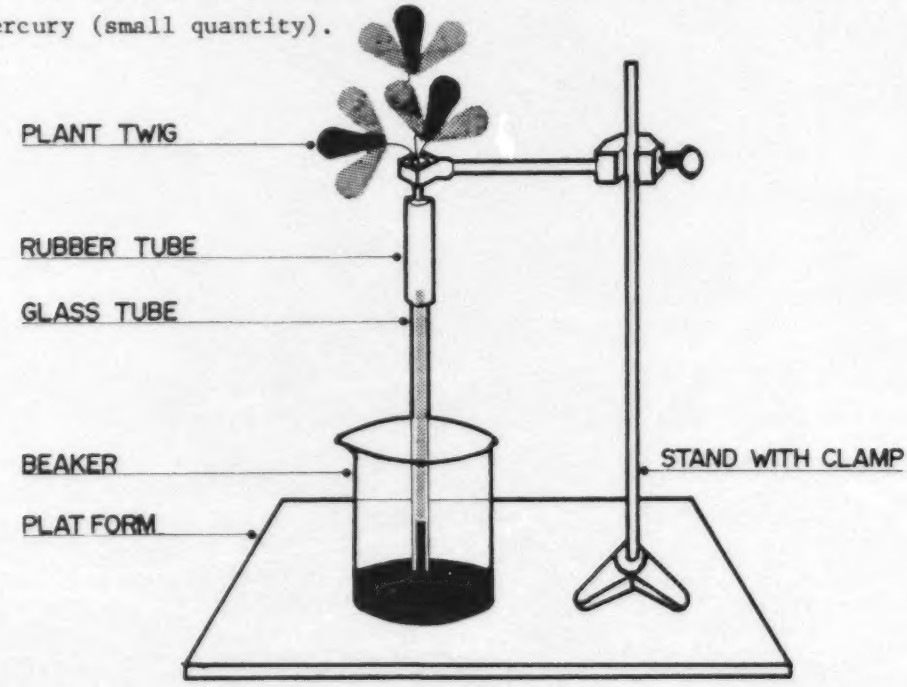
The apparatus consists of a narrow glass tube, with its open top end inserted into a strong polyvinyl (plastic) tube. A freshly cut twig with leaves from a healthy plant is inserted into the open end of the rubber tube. The entire length of the glass and the plastic tube is filled with clean water, so that the lower end of the twig is immersed in water. The lower open end of the glass tube is immersed in a small beaker or basin containing vegetable oil.

2. OBJECTIVES

To demonstrate that suction force is developed due to transpiration in plants.

3. MATERIALS NEEDED

1. A thin, narrow glass tube, 600 - 800 mm long, 20 mm diameter.
2. A piece of strong plastic (polyvinyl) 50 - 80 mm long and with a diameter that fits the glass tube.
3. A small beaker made of glass or transparent plastic.
4. A freshly-cut healthy twig with leaves.
5. A long supporting stand and rod, or a tripod stand (if necessary).
6. Mercury (small quantity).



4. HOW TO MAKE

1. Take the narrow glass tube with smooth ends and check their smoothness by rubbing the ends over a smooth surface.
2. Insert one end of the glass tube into the fitting plastic tube.
3. Take a fresh cut twig with leaves from a healthy plant. Insert the stem of the twig into the other end of the short plastic tube.
4. Fix the plastic tube tightly at its junctions with the glass tube and with the twig stem so as to make the junctions water-tight. To further ensure the water-tightness, seal the surfaces at the plastic tube ends with sealing eax or glue.

5. HOW TO USE

1. Pour some vegetable oil in the beaker, placed on the table, beside the tripod stand.
2. Invert the glass tube with its open end at the top. Pour clean water into it and fill th entire length of the glass tube with water.
3. Close the open end of the glass tube with a finger and invert it so that the twig end is at the top.
4. Keeping the end of the glass tube sealed with your finger immerse the lower end in the vegetable oil while keeping the tube in vertical position. Remove your finger.
5. Fix the glass tube in an upright position, with the twig at the top, by means of a jaw clamp, with its jaw holding the twig stem and its arm end clamped to the long support rod standing on a heavy base. In this position, the surface of contact between the vegetable oil and the water in the glass tube will be clearly visible.
6. Direct the students to make the following observation:
   a. Shortly after the experiment is set up, the surface of contact of the vegetable oil and water is found to gradually rise in the glass tube, demonstrating that some sort of a suction force is developed due to the transpiration process in the plant twig.
   b. Guide the students to reach to the conclusion that some water is sucked by the plant twig through its stem and the temporary vacuum thus created is fulled up by the vegetable oil, which, in turn, is forced up the tube due to the atmospheric pressure on the vegetable oil open surface in the beaker.

Source: Developed at the Bangladesh Educational Equipment Development Bureau, Dacca, Bangladesh, 1980.

Level: Primary and lower secondary

PLASTIC BEAKER

Subject area: Chemistry and environmental studies science

1. BRIEF DESCRIPTION

An improvised piece of apparatus from a discarded powder can, which can be used in place of a beaker.

2. OBJECTIVES

To contain and pour ordinary non-corrosive liquids (e.g. water, alchohol, kerosene, oil).

3. MATERIALS NEEDED

An empty discarded cylindrical plastic powder container with diameter about 50 mm and height 150 mm.

4. HOW TO MAKE

1. Cut the empty plastic powder container into two parts as indicated in Fig. 1.

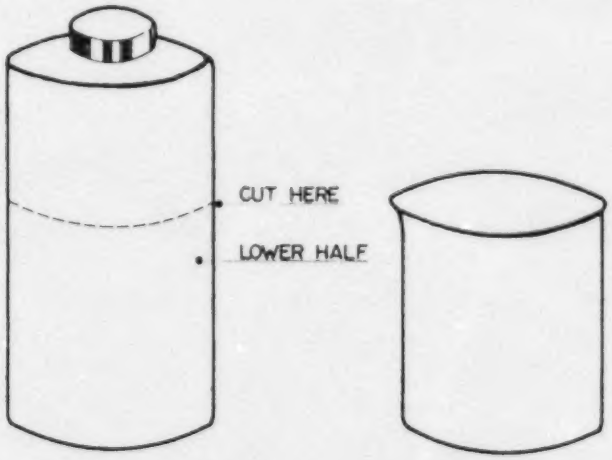


Fig. 1 Fig. 2

2. Fire polish the cut edge of the lower half using a spirit burner.
3. Heat a small area near the edge to softening point and press with a glass rod or a wire nail to make a lip (see Fig. 2). When colled, the beaker is ready for use.

5. HOW TO USE

Use as a beaker for all purposes where no heating is involved.

Source: Report of the Workshop on Educational Technology, Colombo, Sri Lanka, 1980.

BAMBOO THERMOFLASK

Level: All levels
Subject area: All subjects

1. BRIEF DESCRIPTION

This is an inexpensive improvised thermoflask made of locally available materials. It is not a vacuum flask.

2. MATERIALS NEEDED

1. A piece of bamboo with three joints, large enough to house the wrapped bottle.
2. A 500 ml cylindrical bottle with cork.
3. Piece of woolen cloth.
4. Saw dust.

3. HOW TO MAKE

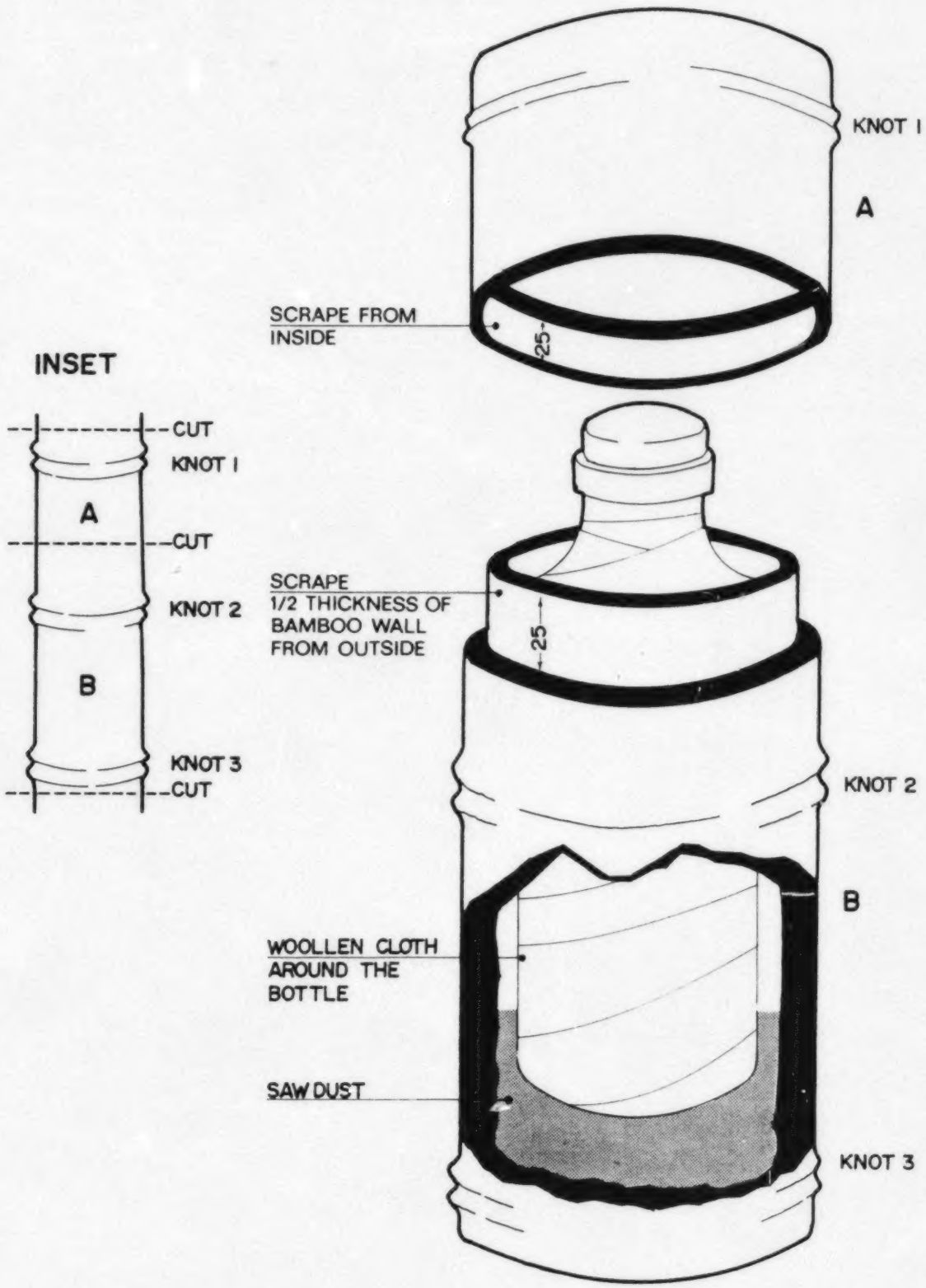
1. Cut the bamboo into two parts A and B so that part B is twice as long as part A.
2. Scrape out about 25 mm of the inner side of the upper part A (for cover) and about 25 mm of the outside of the lower part B (for the flask container) with a sharp knife and file the surfaces so that A fits tightly over B.
3. Also scrape out the upper knot 2 inside the bamboo part B. Leave the bottom knot 3 in part B and the top knot 1 in part A intact.
4. Put sawdust at the bottom of part B to insulate and to provide a soft bottom under the bottle.
5. Wrap the woollen cloth tightly around the bottle before inserting it inside the bamboo part.
6. Close the mouth of the bottle with the cork.

The flask is ready.

4. HOW TO USE

Either hot liquids or cold drinks can be stored in this flask. The temperature of the substance in the flask is maintained for several hours.

Source: Case Study on the Low-cost Appropriate Educational Materials and Development in India, Educational Technology Series Vol. No. IV, serial No. 1, 1980, Department of Teaching Aids, National Council of Educational Research and Training, New Delhi, India.


KNOT 1
A
SCRAPE FROM
INSIDE
25
INSET
CUT
KNOT 1
A
CUT
KNOT 2
B
KNOT 3
CUT
SCRAPE
1/2 THICKNESS OF
BAMBOO WALL
FROM OUTSIDE
25
KNOT 2
B
WOOLLEN CLOTH
AROUND THE
BOTTLE
SAW DUST
KNOT 3

BAMBOO LETTERING PEN

Level: Secondary
Subject area: Drawing

1. BRIEF DESCRIPTION

This inexpensive simple bamboo lettering pen is a handy teaching aid that can be easily made.

2. OBJECTIVES

1. To prepare a simple learning instrument for drawing letters.
2. To develop a useful teaching aid by using locally available materials.

3. MATERIALS NEEDED

1. A 120 mm long stick of bamboo cane for each lettering pen (see Fig. 1).
2. Sharp knife or razor blade.

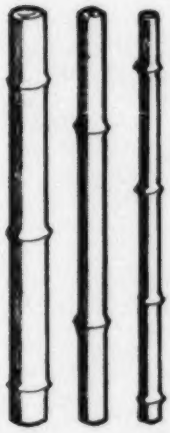


Fig. 1

Fig. 2

Fig. 3

4. HOW TO MAKE

Cut the end of the lettering pen at an angle as shown in Fig. 2. Make sure that the end is flat and even in thickness as this will affect the lettering (Fig. 3).

5. HOW TO USE

Dip the pen in ink and begin lettering.

Source: Second Sub-regional Workshop on Educational Technology, Dacca, Bangladesh, November 1980.

* This particular instruction sheet was developed by the participants from Lao People's Democratic Republic.

IMPROVISED GAS GENERATOR

Level: Secondary
Subject area: Science

1. BRIEF DESCRIPTION

This improvised gas generator is useful for all chemistry laboratories in secondary schools. It consists of a large bottle with its mouth closed by a tightly fitting rubber stopper with two holes. A narrow glass tube with funnel shaped mouth is inserted through one of the holes of the rubber stopper and its lower end is extended to the bottom of the bottle (dipped in the sulphuric acid). Another narrow glass tube is inserted through the second hole of the rubber stopper, so as to collect the hydrogen sulphide gas from the top of the bottle. A short rubber tube is connected to the upper bent end of this glass tube. A metal clip can close the passage of the gas through the rubber tubing.

2. OBJECTIVES

To produce controlled quantities of hydrogen sulphide gas (H_2S) supply for classroom/laboratory use.

3. MATERIALS USED

1. A large glass bottle, (about 50 - 70 mm in diameter and 250 - 300 mm long).
2. A wide glass tube, about 30 mm in diameter, 150 mm long for extension of the narrow glass tube with funnel shaped mouth.
3. One glass funnel extended into a narrow glass tube, 4 mm in diameter and 180 mm long.
4. One bent narrow glass tube, 4 mm in diameter, with a 100 mm long, straight part and bent at the end. (The bent end is about 30 mm long).
5. Two rubber stoppers with appropriate dimensions, one with two holes to fit tightly in the mouth of the bottle and a smaller one to fit the extension tube.
6. A short piece of rubber tubing.
7. One metal clip.
8. Diluted sulphuric acid and ferrous sulphide.

4. HOW TO MAKE

1. Bore two holes in the bigger rubber stopper, with appropriate diameter for the two narrow glass tubes to fit tightly into the holes. Insert the two glass tubes as shown in the figure and explained in the description of the apparatus.

2. Tightly fit the rubber stopper into the mouth of the glass bottle with the funnel shaped mouth glass tube and its extension inside the bottle. See that the lower end of the extended wider tube is reaching the bottom of the bottle. If necessary, adjust the length by drawing the attached narrow tube (funnel) in and out through the hole in the rubber stopper.

3. Insert the straight stem of the bent narrow glass tube through the other hole of the rubber stopper and connect a tight-fitting piece of rubber tubing to the bent end. If the connection is not tight, tie it with string and apply some sealing material around the junction.

4. Fix the metal clip at the end of the rubber tubing.

5. HOW TO USE

1. Put solid crystals of ferrous sulphide inside the bottle and tightly fix the stopper in its position.

2. Close the rubber tube with the metal clip to prevent any outside air from entering into the bottle.

3. Pour some diluted sulphuric acid into the bottle through the funnel shaped narrow glass tube.

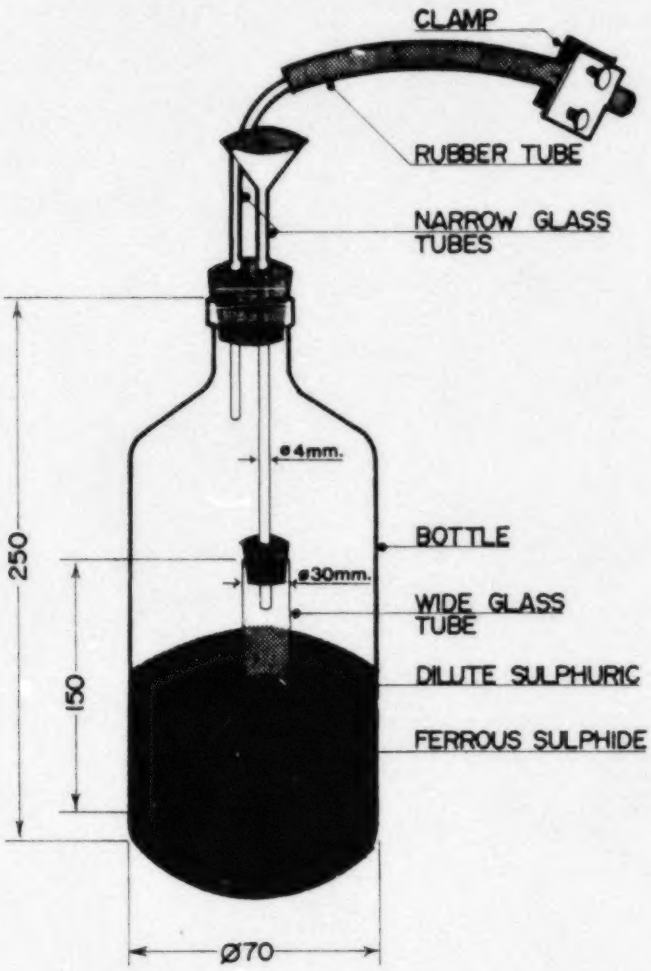
4. Draw the students' attention to the chemical reaction taking place in the bottle as the sulphuric acid comes into contact with the ferrous sulphide crystals and as a result some hydrogen sulphide gas is produced.

5. At the beginning of the experiment loosen the metal clip on the rubber tube for the first two or three minutes to let the air from inside the bottle escape into the atmosphere and then tighten the clip on the rubber tube to close the passage.

6. As the hydrogen sulphide gas continues to be produced, the pressure of the gas inside the bottle and the narrow tube continues to build up steadily. The sulphuric acid inside the extended wider tube will rise, ultimately leaving the bottom of the bottle almost drained of the sulphuric acid. As a result, the chemical reaction ceases. Consequently, at this stage no more hydrogen sulphide gas is produced. The bottle, however, remains full of hydrogen gas under pressure.

7. To let some of the hydrogen sulphide gas out of the bottle, loosen the metal clip on the rubber tube. The hydrogen sulphide gas, which has higher pressure than the outside air, escapes from the bottle through the narrow glass tube and the attached rubber tube. As the hydrogen sulphide gas is released from the bottle, the pressure inside the bottle decreases and as a result, the sulphuric acid which was forced to rise inside the wide tube gradually returns to the bottom of the bottle. A chemical reaction between the sulphuric acid and the ferrous sulphide starts again, producing hydrogen sulphide gas. The metal clip on the rubber tube is tightened to prevent any further gas escaping from the bottle.

As more and more gas is produced, the pressure inside the bottle again builds up, which again forces the sulphuric acid to rise inside the wide tube and hence, the production of hydrogen sulphide gas stops again. Thus, it becomes a repeatable process, allowing controlled production and supply of hydrogen sulphide gas.



Source: Developed at the National Workshop at Dacca on Low-cost Educational Materials in January 1980.

ANNEX

LIST OF PARTICIPANTS

of

APEID Second Sub-regional Workshop in Educational Technology with Special Reference to Development of Low-cost Educational Materials

(Dacca, 27 October - 8 November 1980)

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